

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TM 11-642

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TO 16-30URC20-5

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# RADIO SETS

## AN/VRC-20, -21, AND -22



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*DEPARTMENTS OF THE ARMY AND THE AIR FORCE*

*JULY 1952*







DEPARTMENT OF THE ARMY TECHNICAL MANUAL  
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER  
RADIO SETS AN/VRC-20, AN/VRC-21, AND AN/VRC-22

C 1, TM 11-642

TO 16-30VRC20-5

TM 11-642/TO 16-30VRC20-5, 11 July 1952,  
is changed as follows:

The title of the manual is changed to read:

**RADIO SETS**

**AN/VRC-20, AN/VRC-21, AND AN/VRC-22**

**62.1. Antijamming Procedures**

(Added)

When the radio sets are jammed by unwanted signals, notify the immediate superior officer promptly, and continue to operate the equipment under any condition. Make no reference to the effect of the jamming signals during transmission. Follow the procedures below until the desired signal read-through is possible and communication re-established.

a. Turn the TENTH MCS tuning knob (fig. 4) to the extreme counterclockwise position. This will cause the detent to release and permit continuous tuning. Slowly vary the tuning knob of the jammed radio set, first to one side and then to the other side of the assigned frequency. This may affect some separation of the desired signal from the undesired jamming signal. If the auxiliary receiver is being jammed by unwanted signals, vary the TUNING control (fig. 6) of the receiver to one side, and then the other side of the

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WASHINGTON 25, D. C., 3 September 1954

desired signal frequency. This may re-establish signal read-through of the desired signal on one or the other side of the assigned frequency.

b. Vary the SQUELCH control (fig. 4) slowly, from one position to another. If the strength of the jamming signal remains the same, operate the control to the OFF position.

c. Locate the radio set so that an object such as a tree, truck, tank, or jeep is between the source of the jamming signal and the antenna. The strength of the jamming signal may be decreased or entirely eliminated.

d. If the above procedures fail to produce the desired results, request a change in frequency and call sign.

e. If, after a change in frequency and call sign, signal read-through is still impossible, use another means to get the message through and continue to operate the equipment. Continued operation of the equipment may cause the enemy to be uncertain of the jamming success and to cease transmitting the jamming signal, or switch to other frequencies. Continued operation of the radio set transmitter will keep the enemy uncertain as to the jamming success at what the enemy believes is the active communicating frequency of the radio transmitter.

**Section V. PREVENTIVE MAINTENANCE**

(Added)

**63.1. Definition of Preventive Maintenance**

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept at a minimum. Preventive maintenance differs from trouble shooting and repair because its object is to *prevent* certain troubles from occurring.

**63.2. General Preventive Maintenance Techniques**

a. Use #000 sandpaper to remove corrosion.

b. Use a dry, clean, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD), and wipe the parts dry with a dry cloth.



- (2) Clean electrical contacts with a cloth moistened with carbon tetrachloride and wipe them dry with a dry cloth.

**Caution:** Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Be sure that adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places. Be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

### 63.3. Use of Preventive Maintenance Forms (figs. 33.1 and 33.2)

a. The decision as to what items on DA Forms 11-238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment—Radio Communication, Direction Finding, Carrier, Radar) and 11-239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment—Radio Communication, Direction Finding, Carrier, Radar) are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/ chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 33.1 and 33.2 are partially or totally applicable to Radio Sets AN/VRC-20, AN/VRC-21, and AN/VRC-22. References in the ITEM block refer to paragraphs in text which contain additional maintenance information.

### 63.4. Performing Exterior Preventive Maintenance

**Caution:** Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be broken or damaged.

a. Check for completeness and satisfactory condition of the radio sets. The components of the radio sets are listed in the table in paragraph 6, and are illustrated in figures 3 through 17.

b. Check suitability of location and installation for normal operation (par. 4b).

c. Remove dirt and moisture from the antenna, microphones, headsets, chest sets, connectors, carrying bags, and all control panels.

d. Inspect seating of items readily accessible from the exterior of the set, such as pilot lamps, fuses, connectors, and switches.

e. Inspect controls for binding, scraping, excessive looseness, worn and chipped gears, misalignment, and positive action.

f. Clean and tighten the exterior of components and cases, shock mounts, antenna mount, coaxial transmission lines leading from the radio set to the antenna, and all cable connections.

g. Inspect cases, mounting, antenna, and all metal surfaces for rust, corrosion, and moisture.

h. Inspect cords, cables, wires and shock mounts for fraying, deterioration, kinks, and strains.

i. Inspect the antenna for corrosion, loose fit, and damaged insulator.

j. Inspect canvas bags, technical manuals, and cabling for mildew, tears, and fraying.

k. Inspect accessible items such as knobs, switches, volume control, squelch control, and pilot lamp assemblies for looseness.

l. Inspect storage batteries for dirt, loose terminals, electrolyte level, specific gravity of electrolyte, and damaged cases.

m. Inspect the meter dial, and all dial windows for broken and damaged glass.

n. Clean the nameplate, dial and meter windows, and pilot lamp assemblies.

o. Inspect shelters and covers for adequacy of waterproofing.

### 63.5. Performing Interior Preventive Maintenance

**Caution:** Disconnect all power before performing the following operations. Upon completion, reconnect the power and check for satisfactory operation.

a. Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket tension; remove dust and dirt carefully; if a tube checker is available, check the emission of receiver-type tubes.

b. Inspect fixed capacitors for leaks, bulges, discoloration, and corrosion.

c. Inspect relay assemblies for loose mountings, burned, pitted, or corroded contacts, misalignment of contacts and springs, insufficient spring tension, and binding of armatures and hinged parts.



d. Inspect variable capacitors for dirt, moisture, misalignment of plates, and loose mountings.

e. Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

f. Inspect terminals of large capacitors and resistors for corrosion, dirt, and loose contacts.

g. Clean and tighten switches, relay cases, and interiors of chassis and cabinets not readily accessible.

h. Lubricate the equipment in accordance with applicable Department of the Army Lubrication Order.

i. Inspect Generator G-8/GRC (used for field installations) for brush wear, spring tension, arcing, and fitting of commutator (see TM 11-5037, Generator G-8/GRC).

j. Clean and tighten connections and mountings of transformers, chokes, and potentiometers.

k. Inspect chokes, transformers, and potentiometers for overheating and oil leakage.

l. Before shipping or storing, remove the batteries from Remote Control C-433/GRC, Local Control C-434/GRC, and Case CY-590/GRC.

m. Inspect for leaking waterproof gaskets, and for worn and loose parts of gaskets.

n. Check to see that components have received adequate moistureproof and fungiproof treatment.

### 63.6. Lubrication, Weatherproofing, Rustproofing, and Painting

a. *Lubrication.* The only component of Radio Sets AN/VRC-20, AN/VRC-21, and AN/VRC-22 which may require lubrication in the field is Mounting MT-299/GR. Graphite, or other suitable lubricant should be used on the following parts:

- (1) Metal rack hinges.
- (2) Wing nut fasteners.
- (3) Rails on inner part of U-shaped castings.
- (4) Locking connector for slide in control unit.
- (5) Locking levers and locking strips.

b. *Weatherproofing.*

(1) *General.* When operated under the severe climatic conditions of tropical, arctic, and desert regions, this equipment requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

(2) *Tropical maintenance.* A special moistureproofing and fungiproofing treatment has been given to all components of these radio sets at the factory. This treatment provides a reasonable degree of protection. Refer to TB SIG 13 and TB SIG 72.

(3) *Winter maintenance.* Special precautions necessary to prevent poor performance, or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

(4) *Desert maintenance.* Special precautions to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

c. *Rustproofing and painting.*

(1) When the finish on the units has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use #00 or #000 sandpaper to clean the surface down to the bare metal. Obtain a bright smooth finish.

**Caution:** Do not use steel wool. Minute particles frequently enter the units and cause harmful internal shorting or grounding of circuits.

(2) When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust, and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations. Refer to TM 9-2851.



**OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT**  
**RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR**

*INSTRUCTIONS: See other aide*

EQUIPMENT NOMENCLATURE **RADIO SETS AN/VRC-20, AN/VRC-21, AND AN/VRC-22** EQUIPMENT SERIAL NO. \_\_\_\_\_

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ① Defect corrected.  
 NOTE: Strike out items not applicable.

**DAILY**

NO.	ITEM	CONDITION						
		S	M	T	W	T	F	S
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories). PAR.63.4a							
②	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR.63.4b							
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.							
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.							
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION.							
⑥	CHECK FOR NORMAL OPERATION.							

**WEEKLY**

NO.	ITEM	CON- DIT- ION	NO.	ITEM	CON- DIT- ION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.		15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	PAR.63.4m
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWER-STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
19	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

**DA FORM 11-238**  
 1 MAY 51

REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

**TM 642-CI-1**

*Figure 33.1 (Added) DA Form 11-238.*

**TAGO 1045A**



SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT			
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR			
INSTRUCTIONS: See other side			
EQUIPMENT NOMENCLATURE		EQUIPMENT SERIAL NO.	
RADIO SETS AN/VRC-20, AN/VRC-21, AND AN/VRC-22			
LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; ① Defect corrected. NOTE: Strike out items not applicable.			
NO	ITEM	NO	ITEM
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying case, wire and cable, microphone, tubes, spare parts, technical manuals and accessories).	19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	20	INSPECT FIRM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.	21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION.
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.	22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION.	23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.
6	CHECK FOR NORMAL OPERATION.	24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE.
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.	25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	28	CHECK SETTINGS OF ADJUSTABLE RELAYS.
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.	30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR. PAR.63.5
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE.
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES. PAR.63.5
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.
		37	MOISTURE AND FUNGIPROOF.
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.		

DA FORM 11-239  
1 MAY 51

REPLACES DA FORM 439, 1 DEC 50, WHICH IS OBSOLETE.

16-48227-1

TM 642-CI-2

Figure 33.2 (Added) DA Form 11-239.



BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

M. B. RIDGWAY,  
General, United States Army,  
Chief of Staff.

OFFICIAL:

JOHN A. KLEIN,  
Major General, United States Army,  
The Adjutant General.

OFFICIAL:

K. E. THIEBAUD,  
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SigC Sec, Gen Depots (10)  
SigC Depots (20)  
POE (2)  
OS Sup Agencies (2)  
SigC Fld Maint Shops (3)  
SigC Lab (5)  
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Units organized under following T/O & E's:

11-127, Sig Rep Co (2)  
11-128A, Sig Depot Co (2)  
11-500A (AA thru AE), Sig Admin Team (2)  
11-587, Sig Base Maint Co (2)  
11-592, Hq & Hq Co, Sig Base Depot (2)  
11-597, Sig Base Depot Co (2)

NG: None.

USAR: None.

Unless otherwise noted, distribution applies to ConUS and overseas.

For explanation of abbreviations used, see SR 320- 50-1.











TECHNICAL MANUAL  
RADIO SETS AN/VRC-20, -21, AND -22

TM 11-642 }  
CHANGES No. 2 }

DEPARTMENT OF THE ARMY  
WASHINGTON 25, D. C., 30 September 1955

TM 11-642, 11 July 1952, is changed as follows:

### 18. Audio Accessories

\* \* \* \* \*

*e. Handset H-33/PT.* Handset H-33/PT (fig. 15) \* \* \* the control units. (For a complete description of Handsets H-33D/PT and H-33E/PT, see TB SIG 265.)

### 23. Mounting MT-297/GR

\* \* \* \* \*

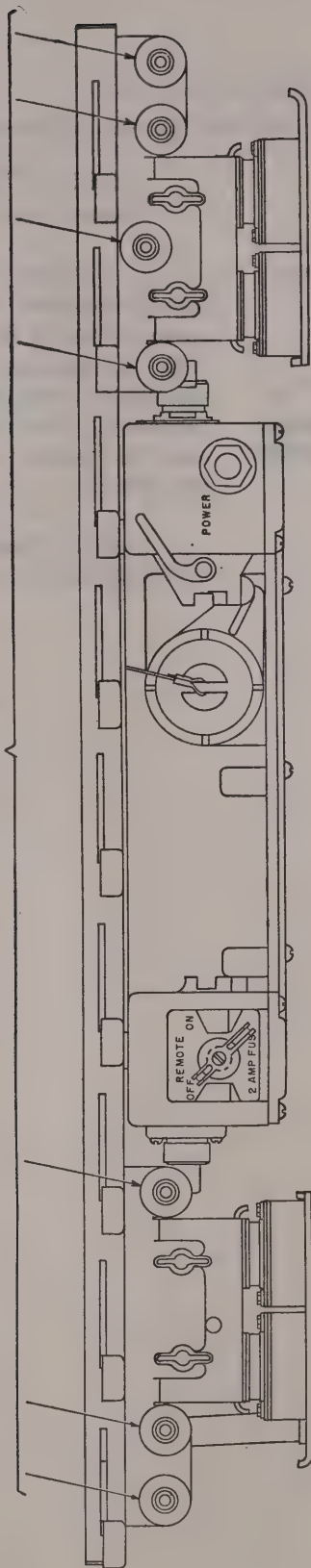
*g. l.* (Added) In late models, and in early models modified by MWO SIG 78, a jumper connects terminals E and E1 of terminal board E-2. In these equipments, the auxiliary receiver and the receiver-transmitter are monitored simultaneously. To monitor the auxiliary receiver and the receiver-transmitter separately, remove this jumper.

\* \* \* \* \*

*o.* (Added) Connect unused cables to the unused-cable mounts (fig. 19 and 19.1).



UNUSED-CABLE MOUNTS



TM642-C2

Figure 19.1 (Added) Location of unused-cable mounts.



### 34. Interconnections

Make the system interconnections outlined below and illustrated in figure 27.

d. Check that the \* \* \* the receiver-transmitter. (If not already done, apply MWO SIG 147, to the cable assembly.) Tighten the screw \* \* \* the shock mounts.

### 36. Receiver-Transmitter Antenna Tuning

The receiver-transmitter \* \* \* the following adjustments.

b. *Transmitter Tuning.* Perform steps 1 \* \* \* proceed as follows:

(2) Turn the TRANS \* \* \* obtain minimum coupling.

*Note.* (Added) If the transmitter antenna coupling control stop fails to function properly, and when new equipment is received, follow instructions in TM 11-289.

### 63.4 Performing Exterior Preventive Maintenance

**Caution:** Tighten screws, bolts \* \* \* broken or damaged.

d. (Rescinded)

Figures 33.1 and 33.2. Item 4 is deleted.

## CHAPTER 5

## ORGANIZATIONAL MAINTENANCE

### Section I. PREVENTIVE MAINTENANCE

Rescinded

#### 93.1 Interchangeable Tubes

(Added)

A preferred type electron tube, type 5654/6AKW, has been developed as a direct replacement for tube type 6AK5. These tubes may be used interchangeably in the rf amplifier stage, V1, of the receivers and receiver-transmitters, and in the mixer stage, V2, of the receivers. The older type tube should be used until stocks are exhausted.

#### 93.2 Electron Tube Replacement Techniques

(Added)

Before attempting removal of electron tubes, inspect all cabling, connections, and the general condition of the equipment. Isolate the trouble, if possible, to a particular unit or section of the equipment.

a. If a tube tester is available, remove and test one tube at a time. If it is necessary to remove more than one tube at a time, tag each one to be sure that it will be replaced in its original socket if it tests as a good tube. Substitute new tubes only for those which are defective.

**Caution:** Do not discard tubes just because they test at or near the minimum limit acceptable on the tube tester. Many new tubes test near the lower limit of the acceptable range, and still

provide satisfactory performance for a long time at this value.

b. If a tube tester is not available, use the tube substitution method as follows:

(1) Replace the suspected tubes, one at a time, with new tubes. Note the sockets from which the original tubes were removed. If the equipment becomes operative, discard the last tube removed.

*Note.* Each of the oscillators (V3, V10, V11, V101, V103, and V104) may function with one tube and not another, even though both tubes are new. If possible, hold any removed tube until it can be checked in a tube tester.

(2) Replace the remaining original tubes, one at a time, in their original sockets. If equipment failure occurs during this step, discard the last original tube. DO NOT LEAVE A NEW TUBE IN A SOCKET IF THE EQUIPMENT OPERATES SATISFACTORILY WITH THE ORIGINAL TUBE.

(3) If there are not enough spare tubes, proceed as follows:

(a) Substitute a new tube for one original tube. If the equipment still does not operate, replace the new tube with the original. Check the remainder of the tubes, one at a time, in this way until the equipment operates properly.



(b) Often it is possible to remove a tube from one section of the equipment without affecting the section being checked. In such a case, troubleshoot the defective section. Use this tube as a substitute spare.

*Note.* If a replacement for a bad tube soon becomes defective, check the adjustment and condition of component parts of the tube circuit. In the receiver-transmitters, also check for proper tuning; otherwise, continued tube replacement will only result in temporary repair and may cause more serious troubles.

c. If tube replacement does not correct the trouble, *return the original tubes to their sockets* before forwarding the defective equipment for higher echelon repair.

d. Discard tubes *only* when a test in a tube tester or other instrument shows that the tube is defective, or when the tube defect, such as a broken glass envelope, open filament, or a broken connecting prong or lead, is obvious.

e. *Do not* discard tubes just because the tubes have been used for a specified length of time. *Satisfactory operation in a circuit is the final proof*

[AG 413. 44 (17 Aug 55)]

BY ORDER OF THE SECRETARY OF THE ARMY:

OFFICIAL:

JOHN A. KLEIN,  
Major General, United States Army,  
The Adjutant General.

DISTRIBUTION:

Active Army:

CNGB (1)	Gen & Br Svc Sch (5)	6-200R (2)	11-500R (AA-AE) (2)
Tec Svc, DA (1) except	except SigC Sch (25)	6-226R (2)	11-557R (2)
CSIGO (30)	Gen Depots (2) except	6-229R (2)	11-587R (2)
Tec Svc Bd (1)	Atlanta Gen Depot	6-236R (2)	11-592R (2)
CONARC (5)	(None)	6-416R (2)	11-597R (2)
CONARC Bd (incl ea	SigC Sec, Gen Depots	6-419R (2)	17-32R (2)
Test Sec) (1)	(10)	6-447R (2)	17-36R (2)
Army AA Comd (2)	SigC Depots (20)	7-11R (2)	17-37R (2)
OS Maj Comd (5)	POE (2)	7-31R (2)	17-116R (2)
OS Base Comd (5)	OS Sup Agencies (2)	7-36R (2)	17-117R (2)
Log Comd (5)	SigC Fld Maint Shops(3)	8-37R (2)	17-125R (2)
MDW (1)	SigC Lab (5)	11-7R (2)	19-97R (2)
Armies (5)	Mil Dist (1)	11-16R (2)	44-276R (2)
Corps (2)	Units organized under	11-57R (2)	44-277R (2)
Tng Div (2)	following TOE's:	11-127R (2)	
Ft & Cp (2)	5-226R (2)	11-128R (2)	

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see SR 320-50-1.

of tube quality. The tube in use may work better than a new one.

f. Use special care when removing a miniature tube from its socket. Do not rock or rotate the top — pull it straight out; otherwise, a broken lead or an intermittent joint may result.

#### 94. Equipment Performance Checklist

b. Use. The check list is the following columns:

(5) Possible defective units. This column refers of being defective.

**Caution:** Do not mishandle tubes; refer to paragraph 93.2.

Figure 78. The following is added to the left of E-2: (SEE NOTE 3).

The following note is added:

3. IN LATE MODELS, AND IN MODIFIED EARLY MODELS, A JUMPER CONNECTS TERMINALS E AND E1 OF TERMINAL BOARD E-2. TO MONITOR THE AUXILIARY RECEIVER AND THE RECEIVER-TRANSMITTER SEPARATELY, REMOVE THIS JUMPER.

MAXWELL D. TAYLOR,  
General, United States Army,  
Chief of Staff.



DEPARTMENT OF THE ARMY TECHNICAL MANUAL  
DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER  
RADIO SETS AN/VRC-20, AN/VRC-21, AND AN/VRC-22

C 1, TM 11-642  
TO 16-30VRC20-5

DEPARTMENTS OF THE ARMY AND  
THE AIR FORCE  
WASHINGTON 25, D. C., 3 September 1954

TM 11-642/TO 16-30VRC20-5, 11 July 1952,  
is changed as follows:

The title of the manual is changed to read:

**RADIO SETS**

**AN/VRC-20, AN/VRC-21, AND AN/VRC-22**

**62.1. Antijamming Procedures**

(Added)

When the radio sets are jammed by unwanted signals, notify the immediate superior officer promptly, and continue to operate the equipment under any condition. Make no reference to the effect of the jamming signals during transmission. Follow the procedures below until the desired signal read-through is possible and communication re-established.

a. Turn the TENTH MCS tuning knob (fig. 4) to the extreme counterclockwise position. This will cause the detent to release and permit continuous tuning. Slowly vary the tuning knob of the jammed radio set, first to one side and then to the other side of the assigned frequency. This may affect some separation of the desired signal from the undesired jamming signal. If the auxiliary receiver is being jammed by unwanted signals, vary the TUNING control (fig. 6) of the receiver to one side, and then the other side of the

desired signal frequency. This may re-establish signal read-through of the desired signal on one or the other side of the assigned frequency.

b. Vary the SQUELCH control (fig. 4) slowly, from one position to another. If the strength of the jamming signal remains the same, operate the control to the OFF position.

c. Locate the radio set so that an object such as a tree, truck, tank, or jeep is between the source of the jamming signal and the antenna. The strength of the jamming signal may be decreased or entirely eliminated.

d. If the above procedures fail to produce the desired results, request a change in frequency and call sign.

e. If, after a change in frequency and call sign, signal read-through is still impossible, use another means to get the message through and continue to operate the equipment. Continued operation of the equipment may cause the enemy to be uncertain of the jamming success and to cease transmitting the jamming signal, or switch to other frequencies. Continued operation of the radio set transmitter will keep the enemy uncertain as to the jamming success at what the enemy believes is the active communicating frequency of the radio transmitter.

**Section V. PREVENTIVE MAINTENANCE**

(Added)

**63.1. Definition of Preventive Maintenance**

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept at a minimum. Preventive maintenance differs from trouble shooting and repair because its object is to *prevent* certain troubles from occurring.

**63.2. General Preventive Maintenance Techniques**

- a. Use #000 sandpaper to remove corrosion.
- b. Use a dry, clean, lint-free cloth or a dry brush for cleaning.
- (1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, Dry Cleaning (SD), and wipe the parts dry with a dry cloth.



- (2) Clean electrical contacts with a cloth moistened with carbon tetrachloride and wipe them dry with a dry cloth.

**Caution:** Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Be sure that adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places. Be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

### 63.3. Use of Preventive Maintenance Forms (figs. 33.1 and 33.2)

a. The decision as to what items on DA Forms 11-238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment—Radio Communication, Direction Finding, Carrier, Radar) and 11-239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment—Radio Communication, Direction Finding, Carrier, Radar) are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 33.1 and 33.2 are partially or totally applicable to Radio Sets AN/VRC-20, AN/VRC-21, and AN/VRC-22. References in the ITEM block refer to paragraphs in text which contain additional maintenance information.

### 63.4. Performing Exterior Preventive Maintenance

**Caution:** Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be broken or damaged.

a. Check for completeness and satisfactory condition of the radio sets. The components of the radio sets are listed in the table in paragraph 6, and are illustrated in figures 3 through 17.

b. Check suitability of location and installation for normal operation (par. 4b).

c. Remove dirt and moisture from the antenna, microphones, headsets, chest sets, connectors, carrying bags, and all control panels.

d. Inspect seating of items readily accessible from the exterior of the set, such as pilot lamps, fuses, connectors, and switches.

e. Inspect controls for binding, scraping, excessive looseness, worn and chipped gears, misalignment, and positive action.

f. Clean and tighten the exterior of components and cases, shock mounts, antenna mount, coaxial transmission lines leading from the radio set to the antenna, and all cable connections.

g. Inspect cases, mounting, antenna, and all metal surfaces for rust, corrosion, and moisture.

h. Inspect cords, cables, wires and shock mounts for fraying, deterioration, kinks, and strains.

i. Inspect the antenna for corrosion, loose fit, and damaged insulator.

j. Inspect canvas bags, technical manuals, and cabling for mildew, tears, and fraying.

k. Inspect accessible items such as knobs, switches, volume control, squelch control, and pilot lamp assemblies for looseness.

l. Inspect storage batteries for dirt, loose terminals, electrolyte level, specific gravity of electrolyte, and damaged cases.

m. Inspect the meter dial, and all dial windows for broken and damaged glass.

n. Clean the nameplate, dial and meter windows, and pilot lamp assemblies.

o. Inspect shelters and covers for adequacy of waterproofing.

### 63.5. Performing Interior Preventive Maintenance

**Caution:** Disconnect all power before performing the following operations. Upon completion, reconnect the power and check for satisfactory operation.

a. Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket tension; remove dust and dirt carefully; if a tube checker is available, check the emission of receiver-type tubes.

b. Inspect fixed capacitors for leaks, bulges, discoloration, and corrosion.

c. Inspect relay assemblies for loose mountings, burned, pitted, or corroded contacts, misalignment of contacts and springs, insufficient spring tension, and binding of armatures and hinged parts.



d. Inspect variable capacitors for dirt, moisture, misalignment of plates, and loose mountings.

e. Inspect resistors, bushings, and insulators for cracks, chipping, blistering, discoloration, and moisture.

f. Inspect terminals of large capacitors and resistors for corrosion, dirt, and loose contacts.

g. Clean and tighten switches, relay cases, and interiors of chassis and cabinets not readily accessible.

h. Lubricate the equipment in accordance with applicable Department of the Army Lubrication Order.

i. Inspect Generator G-8/GRC (used for field installations) for brush wear, spring tension, arcing, and fitting of commutator (see TM 11-5037, Generator G-8/GRC).

j. Clean and tighten connections and mountings of transformers, chokes, and potentiometers.

k. Inspect chokes, transformers, and potentiometers for overheating and oil leakage.

l. Before shipping or storing, remove the batteries from Remote Control C-433/GRC, Local Control C-434/GRC, and Case CY-590/GRC.

m. Inspect for leaking waterproof gaskets, and for worn and loose parts of gaskets.

n. Check to see that components have received adequate moistureproof and fungiproof treatment.

### 63.6. Lubrication, Weatherproofing, Rustproofing, and Painting

a. *Lubrication.* The only component of Radio Sets AN/VRC-20, AN/VRC-21, and AN/VRC-22 which may require lubrication in the field is Mounting MT-299/GR. Graphite, or other suitable lubricant should be used on the following parts:

- (1) Metal rack hinges.
- (2) Wing nut fasteners.
- (3) Rails on inner part of U-shaped castings.
- (4) Locking connector for slide in control unit.
- (5) Locking levers and locking strips.

#### b. *Weatherproofing.*

(1) *General.* When operated under the severe climatic conditions of tropical, arctic, and desert regions, this equipment requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

(2) *Tropical maintenance.* A special moistureproofing and fungiproofing treatment has been given to all components of these radio sets at the factory. This treatment provides a reasonable degree of protection. Refer to TB SIG 13 and TB SIG 72.

(3) *Winter maintenance.* Special precautions necessary to prevent poor performance, or total operational failure of equipment in extremely low temperatures are explained in TB SIG 66 and TB SIG 219.

(4) *Desert maintenance.* Special precautions to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

#### c. *Rustproofing and painting.*

(1) When the finish on the units has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use #00 or #000 sandpaper to clean the surface down to the bare metal. Obtain a bright smooth finish.

**Caution:** Do not use steel wool. Minute particles frequently enter the units and cause harmful internal shorting or grounding of circuits.

(2) When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust, and to use sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations. Refer to TM 9-2851.



**OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT**  
**RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR**

*INSTRUCTIONS: See other side*

EQUIPMENT NOMENCLATURE **RADIO SETS AN/VRC-20, AN/VRC-21,  
AND AN/VRC-22** EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; ✕ Adjustment, repair or replacement required; (X) Defect corrected.  
 NOTE: Strike out items not applicable.

**DAILY**

NO.	ITEM	CONDITION						
		S	M	T	W	T	F	S
(1)	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories). PAR.63.4a							
(2)	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR.63.4b							
(3)	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.							
(4)	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.							
(5)	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION.							
(6)	CHECK FOR NORMAL OPERATION.							

**WEEKLY**

NO.	ITEM	CONDI- TION	NO.	ITEM	CONDI- TION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.		15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWER-STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	
19	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

**DA FORM 11-238**  
1 MAY 51

REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 642-CI-1

Figure 33.1 (Added) DA Form 11-238.

TAGO 1045A



SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT			
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR			
INSTRUCTIONS: See other side			
EQUIPMENT NOMENCLATURE	RADIO SETS AN/VRG-20, AN/VRG-21, AND AN/VRG-22	EQUIPMENT SERIAL NO.	
LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; ✕ Adjustment, repair or replacement required; ① Defect corrected. NOTE: Strike out items not applicable.			
NO.	ITEM	NO.	ITEM
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).	19	ELECTRON TUBES - INSPECT FOR LOOSE ENVELOPES, CAP CONNECTIONS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.	21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION.
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS.	22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BENDING OF PLUNGERS AND HINGE PARTS.
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION.	23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.
6	CHECK FOR NORMAL OPERATION.	24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE.
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS.	25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.	28	CHECK SETTINGS OF ADJUSTABLE RELAYS.
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.	30	INSPECT GENERATORS, AMPLIFYING, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR. PAR.63.5
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE.
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	33	BEFORE SHIPPING OR STORING - REMOVE BATTERIES. PAR.63.5
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	34	INSPECT CATHODE RAY TUBES FOR BURNED SCREEN SPOTS.
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.
		37	MOISTURE AND FUNGIPROOF.
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.		

DA FORM 11-239  
1 MAY 51

REPLACES DA FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

16-4422-1

TM 642-CI-2

Figure 33.2 (Added) DA Form 11-239.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

M. B. RIDGWAY,  
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*Chief of Staff.*

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NG: None.

USAR: None.

Unless otherwise noted, distribution applies to ConUS and overseas.

For explanation of abbreviations used, see SR 320- 50-1.

SigC Sch (25)  
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SigC Sec, Gen Depots (10)  
SigC Depots (20)  
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SigC Fld Maint Shops (3)  
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Units organized under following T/O & E's:  
11-127, Sig Rep Co (2)  
11-128A, Sig Depot Co (2)  
11-500A (AA thru AE), Sig Admin Team (2)  
11-587, Sig Base Maint Co (2)  
11-592, Hq & Hq Co, Sig Base Depot (2)  
11-597, Sig Base Depot Co (2)









# RADIO SETS

## AN/VRC-20,-21, AND -22



DEPARTMENTS OF THE ARMY  
AND THE AIR FORCE  
WASHINGTON 25, D. C., 11 July 1952

TM 11-642/TO 16-30URC20-5 is published for the information and guidance of all concerned.  
[AG 413.44 (12 Jun 52)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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NG: Same as Active Army except one copy to each unit.

ORC: Same as Active Army except one copy to each unit.

For explanation of distribution formula, see SR 310-90-1.



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# **WARNING**

## **HIGH VOLTAGE**

is used in the operation of  
this equipment.

## **DEATH ON CONTACT**

may result if operating personnel  
fail to observe safety precautions.



# First Aid for Electric Shock

## RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

## SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

## TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than

is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(1) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(2) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(3) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(4) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

(1) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(2) Swing back, suddenly releasing pressure, and sit on the heels.

(3) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4

TL15338-D





**A. CORRECT POSITION.** Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.

**B. FORWARD SWING AND POSITIONING OF HANDS.** Little finger rests on last rib.

**C. DOWNWARD PRESSURE.** Arms and thighs vertical.

**D. REST POSITION.** Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.



seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

**h.** Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

#### RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

#### STIMULANTS.

**a.** If an inhalant stimulant is used, such as aro-

matic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

**b.** After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing  $\frac{1}{2}$  teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

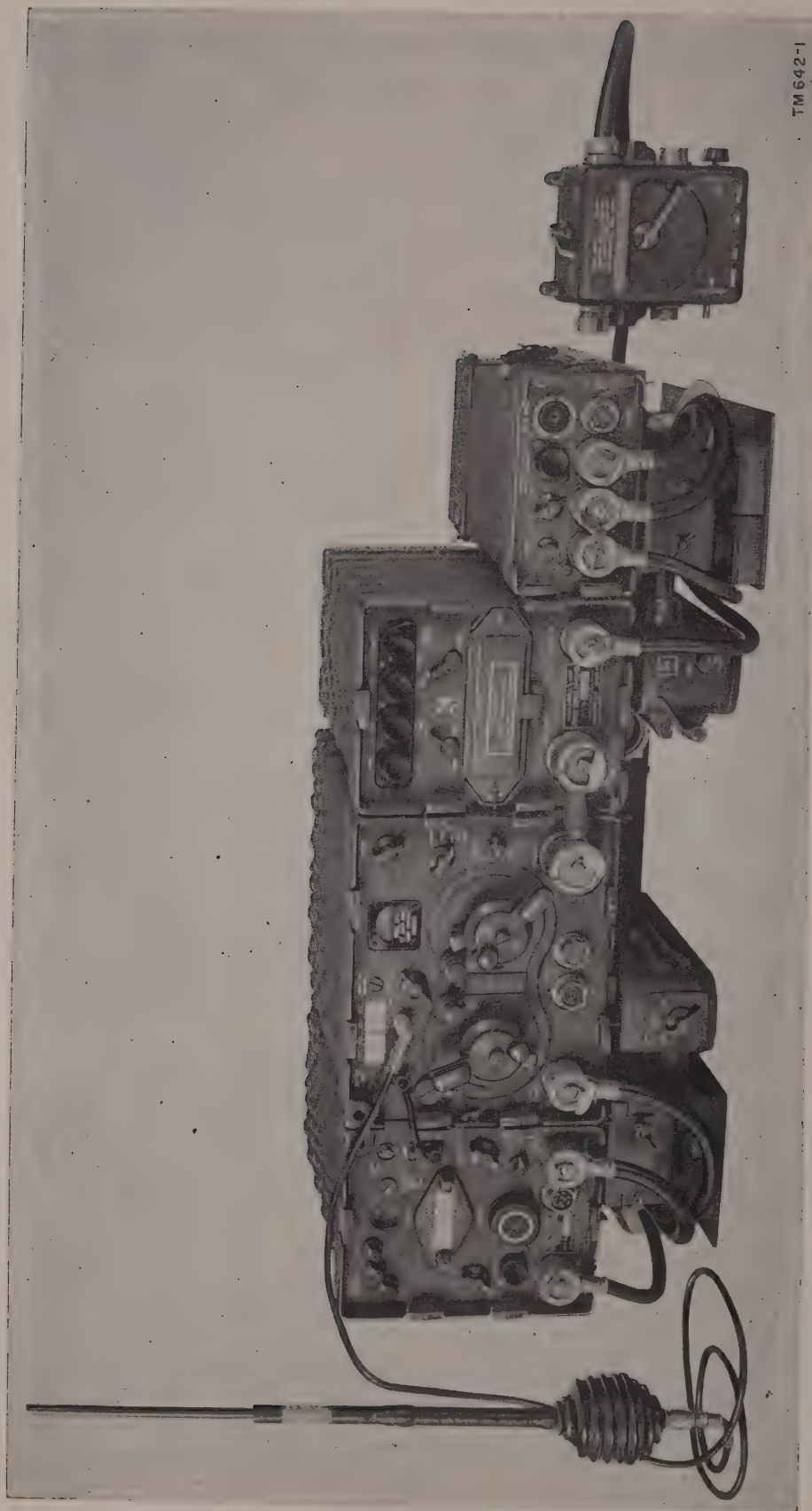
#### CAUTIONS.

**a.** After the victim revives, keep him **LYING QUIETLY**. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

**b.** Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

**c.** A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

TL15338-E



TM 642-1

*Figure 1. Radio Set AN/VRC-20, -21, or -22.*



# CHAPTER I

## INTRODUCTION

### Section I. GENERAL

#### I. Scope

This manual contains instructions for the installation, operation, and organizational maintenance of Radio Sets AN/VRC-20, -21, and -22. The information is intended primarily for operators and organizational maintenance personnel and therefore is restricted to system considerations. Detailed information on the various units which comprise the several systems is presented only to the extent that system applications are involved. Detailed field maintenance instructions for the individual major components are published in separate manuals. In addition to these instructions there are three appendixes covering a list of references, an identification table of parts, and related radio sets.

#### 2. Nomenclature

a. To allow simultaneous treatment of the three sets, a collective nomenclature has been devised to refer to the sets and their respective units. This expedient is outlined in *b* through *h* below.

b. Radio Sets AN/VRC-20, -21, and -22 are referred to collectively as the *radio set* or *sets*. Wherever instructions are limited to a particular set or group of sets, specific reference is made to that set and full nomenclature (for example, Radio Set AN/VRC-20) is used for the set.

c. The term "system" refers to an installed radio set. Each of the radio sets can be installed in a variety of vehicles (par. 7); a different installation unit is required for each vehicle. The combination of a basic unit (radio set) and an installation unit for a particular vehicle constitutes a system.

d. The term "receiver-transmitter" is used to refer collectively to Receiver-Transmitters RT-66/GRC, RT-67/GRC, and RT-68/GRC, which are units of Radio Sets AN/VRC-20, -21, and -22, respectively. The use of a particu-

lar receiver-transmitter to cover a particular frequency range (fig. 2) constitutes the major difference among the radio sets. Minor differences, dependent on frequency range, are indicated in the table of components (par. 6).

e. The term "Set 1", which also is used to indicate the receiver-transmitter, has no distinguishing significance in Radio Sets AN/VRC-20, -21, and -22. In more complex related systems which utilize two receiver-transmitters (app. III), the terms "Set 1" and "Set 2" are used to distinguish the two receiver-transmitters.

f. The term "receiver-transmitter power supply" is used to designate either Power Supply PP-109/GR or PP-112/GR, one of which is used to supply operating voltages for the receiver-transmitter. The vehicular battery voltage available, 12 or 24 volts, determines which power supply must be used. In 12-volt systems, Power Supply PP-109/GR is provided as part of the radio set; in 24-volt systems, Power Supply PP-112/GR is provided.

g. The term "auxiliary receiver" is used to refer collectively to Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC, which are units of Radio Sets AN/VRC-20, -21, and -22, respectively. The frequency range of a particular receiver is almost identical to the frequency range of the receiver-transmitter in the radio set (fig. 2).

h. The term "auxiliary receiver power supply" is used to designate either Power Supply PP-281/GRC or PP-282/GRC, which is used to supply operating voltages for the auxiliary receiver. The vehicular battery voltage available, 12 or 24 volts, determines which power supply must be used. In 12-volt systems, Power Supply PP-281/GRC is used. In 24-volt systems, Power Supply PP-282/GRC is used.

i. The term "interphone amplifier" is used to designate AF Amplifier AM-65/GRC, a common component of the three radio sets.

j. The term "amplifier power supply" is used

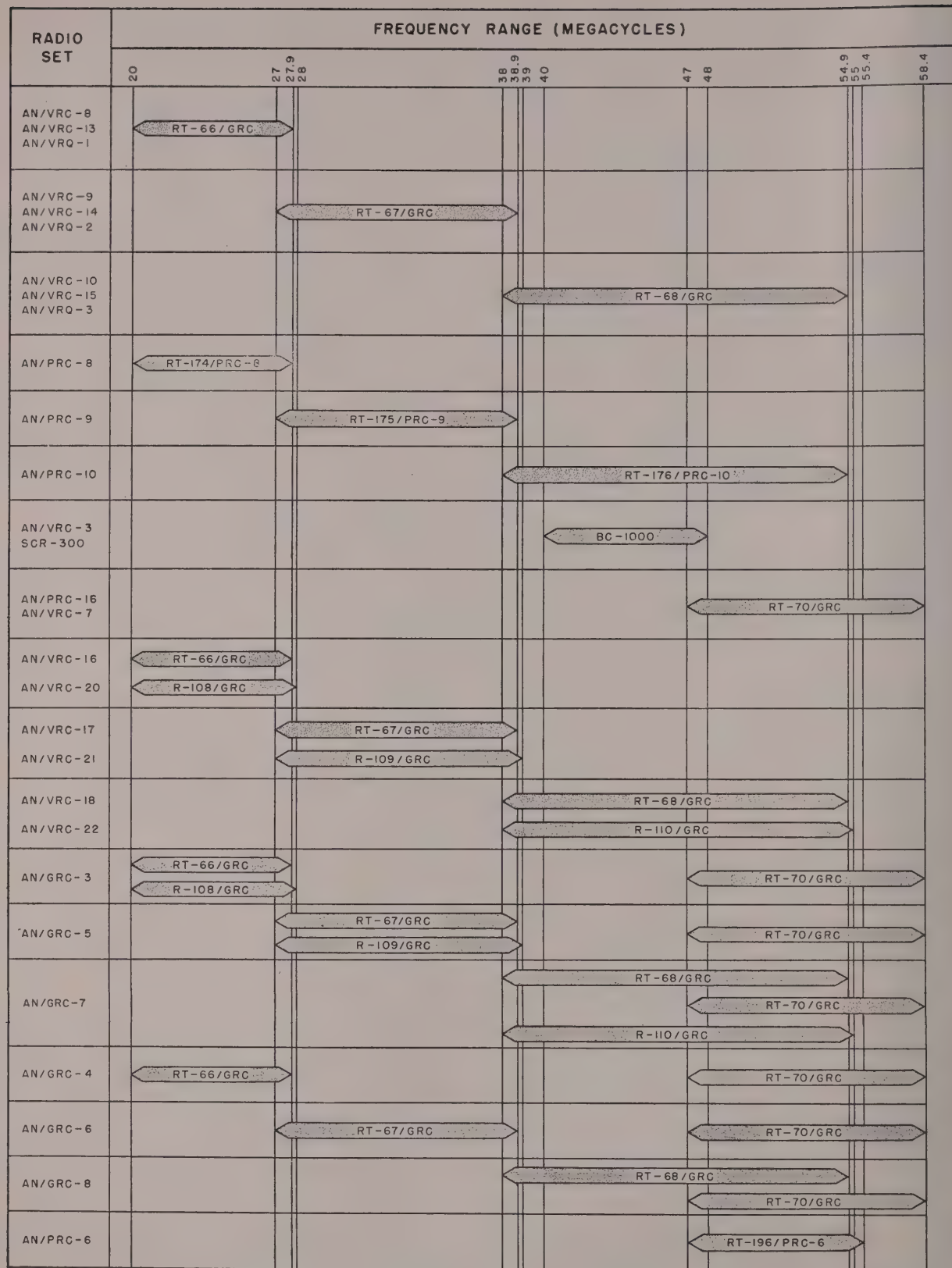


Figure 2. Frequency spectrum chart.

TM642-2



to designate Power Supply PP-281/GRC or PP-282/GRC, either of which is used to supply operating voltage for the interphone amplifier in all of the radio sets. The vehicular battery voltage available, 12 or 24 volts, determines which power supply must be used. In 12-volt systems, Power Supply PP-281/GRC is used. In 24-volt systems, Power Supply PP-282/GRC is used.

k. The term "interphone box" is used to designate Control Box C-375/VRC.

3. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5.

b. DA Form-468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. DA AGO Form 11-238, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

d. DA AGO Form 11-239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form.

e. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

4. Purpose of Equipment

a. Radio Sets AN/VRC-20, -21, and -22 provide f-m (frequency-modulated) radiotelephone facilities within the frequency range of 20 to 54.9 mc (megacycles). The specific frequency range of each set, and of other radio equipment with which the sets can communicate, is indicated in the frequency spectrum chart (fig. 2). As indicated on the chart, the frequency coverage of each radio set is that of its respective receiver-transmitter and is duplicated by the auxiliary receiver, Radio Receiver R-108/GRC, R-109/GRC, or R-110/GRC, respectively.

b. The radio sets can be installed and operated in trucks, personnel carriers, armored utility vehicles, weapons carriers, and other authorized vehicles (par. 7). The sets are designed primarily for short-range operation (10 to 15 miles). Radio Sets AN/VRC-20, -21, and -22 are intended for use by armored, artillery, and infantry units, respectively. A 900-kc (kilocycle) overlap in frequency coverage between Radio Sets AN/VRC-20 and -21 provides for liaison between armored and artillery units; a similar 900-kc overlap between Radio Sets AN/VRC-21 and -22 provides for liaison between artillery and infantry units.

5. Technical Characteristics

Frequency range.....20 to 54.9 mc. in the following bands:

- AN/VRC-20 ..... 20 to 27.9 mc.
- AN/VRC-21 ..... 27 to 38.9 mc.
- AN/VRC-22 ..... 38 to 54.9 mc

Types of transmission and reception. Voice and 1,600-cycle f-m signals.

Types of tuning:

Receiver-transmitter ... Choice of channels or continuous tuning. Choice of detented channels (80, 120, and 170 for Receiver - Transmitters RT-66/GRC, RT-67/-GRC, and, RT-68/GRC, Respectively) at every 100 kc of the tuning range. Provision also is made for presetting any two of the detented channels and for continuous tuning.

Auxiliary receiver .... Continuous tuning with detent provisions for preselection of any three frequencies.

Communication range .. Approximately 10 miles. This range varies according to terrain and atmospheric conditions.

Operating facilities:

Monitoring and push-to-talk operation from local

or remote control stations.  
Interphone facilities.  
Full duplex radio operation.  
Total power drain ..92 to 260 watts, depending upon mode of operation; power drains for individual units as follows:

Unit	Input voltage	Input current (amperes)	
		Stand-by	Transmission
Receiver-transmitter.	12.6	2.3	11.9
	25.2	1.5	7.3
Interphone amplifier.	12.6	2.6	3.2
	25.2	1.4	1.8
Auxiliary receiver.	12.6	2.5	—
	25.2	1.5	—

#### Transmitter r-f (radio-frequency)

Power output ..... Approximately 16 watts on HIGH power; approximately 2 watts on LOW power.

#### Receiver a-f (audio-frequency)

power output:

Receiver-transmitter ... Approximately 1 watt and 50 mw (milliwatts) at speakers and telephone output terminals respectively; approximately 30 mw at fixed level output terminals.

Auxiliary receiver ..... Approximately 1 watt and 50 mw at speaker and telephone output terminals respectively; approximately 30 mw at fixed-level output terminals.

Microphone input impedance. 150 ohms.

Audio output impedance ... 150 ohms at Set 1 + Set 2 + Interphone output of interphone amplifier; 600 ohms at all other audio output terminals.

#### Receiver sensitivity:

Receiver-transmitter ... 30-db (decibel) for RT-66/GRC, 20-db for RT-67/GRC and RT-68/GRC signal-plus-noise to noise ratio with  $\frac{1}{2}$ -uv (microvolt) input signal.

Auxiliary receiver ..... 25-db for R-108/GRC and R-109/GRC, 20-db for R-110/GRC signal-plus-noise to noise ratio with  $\frac{1}{2}$ -uv input signal.

## 6. Table of Components

A composite table of components for the three radio sets is given below. All dimensions and weights are approximate. Although there is only one list of components for each of Radio Sets AN/VRC-20, -21, and -22, the availability of either Power Supply PP-109/GR or PP-112/GR indicates that there are two variations of each radio set. A radio set including Power Supply PP-109/GR is for 12-volt systems; a radio set including Power Supply PP-112/GR is for 24-volt systems.

*Note.* As indicated in paragraph 2, a radio set does not in itself constitute an operating system. For installation and operation in particular vehicles, the additional equipment referred to in paragraph 7 also is required.

Component	Radio sets			Dimensions of components				
	AN/VRC-20	AN/VRC-21	AN/VRC-22	Height (in.)	Depth (in.)	Length (in.)	Volume (cu. ft.)	Unit weight (lb)
Receiver-Transmitter RT-66/GRC .....	1			9	13	11 $\frac{1}{4}$	.76	35
Receiver-Transmitter RT-67/GRC .....		2		9	13	11 $\frac{1}{4}$	.76	35
Receiver-Transmitter RT-68/GRC .....			1	9	13	11 $\frac{1}{4}$	.76	35
Power Supply PP-109/GR or PP-112/GR ...	1	1	1	9	13	8	.54	33
Radio Receiver R-108/GRC .....	1			9	13	7 $\frac{1}{4}$	.50	35
Radio Receiver R-109/GRC .....		1		9	13	7 $\frac{1}{4}$	.50	35
Radio Receiver R-110/GRC .....			1	9	13	7 $\frac{1}{4}$	.50	35
Power Supply PP-281/GRC or PP-282/GRC.	2	2	2	4 $\frac{1}{2}$	6	3	.04	6
AF Amplifier AM-65/GRC .....	1	1	1	4 $\frac{1}{4}$	13	7 $\frac{7}{8}$	.30	15.5
Control Box C-375/VRC .....	1	1	1	7	4	7	.1	3.5
Mounting MT-297/GR .....	1	1	1	5	12	34	1.06	50
Mast Section MS-116-A .....	2	2				39.5	.046	1.6



Component	Radio sets			Dimensions of components				
	AN/VRC-20	AN/VRC-21	AN/VRC-22	Height (in.)	Depth (in.)	Length (in.)	Volume (cu. ft.)	Unit weight (lb)
Mast Section MS-117-A .....	2	2	2			39.5	.042	1.4
Mast Section MS-118-A .....	2	2				39.5	.016	.5
Mast Section AB-24/GR .....			2			23.5	.005	.13
Mast Base AB-15/GR .....	1	1	1					
Special Purpose Cable Assembly CX-1211/U.	1	1	1				.25	.4
Special Purpose Cable WM-46/U .....	1	1	1			120	.4	9
RF Cable Assembly CG-568/U .....	1					50	.01	.5
RF Cable Assembly CG-530/U .....		1	1			50	.01	.5
Adapter UG-306/U .....	1	1	1				.006	.36
Adapter UG-273/U .....	1	1	1				.006	.34
Bag CW-206/GR .....	1	1	1	3 (thk)	5 (wd)	40	.34	3.5
Wire W-142 .....	1	1	1			12	.001	.043
Technical Manual (TM 11-642) .....	2	2	2	8	1/4	10	.08	1
Connector and Bondnut, Appleton Electric Company Nos. 60007 and BL-50 or equal.	1	1	1				.01	.5
Case CY-684/GR .....	1	1	1				.17	3

## 7. Additional Equipment Required

To install and operate any of the basic radio sets listed in the table of components (par. 6), an installation unit also is required. Either a 12-volt or a 24-volt basic unit is common to all installations; a separate installation unit is supplied (or must be requisitioned) for each vehicular installation, since such items as audio accessories, cables, junction boxes, and mounting hardware, vary with the type of vehicle.

## 8. Packaging Data

The basic components of each of the radio sets (par. 6) are packed for shipment in three wooden boxes. The components first are pack-

aged individually in moisture-vaporproof containers and then distributed in the three wooden boxes. The over-all weights and volumes of the three containers are listed in *a* below. The contents of each box are listed in *b* below.

*Note.* Items may be packaged in a manner different from that shown, depending on the supply channels.

### *a. Weights and Volumes of Boxes.*

Box No.	Weight (lb)	Volume (cu ft)
1.....	93	2.10
2.....	150	2.90
3.....	53	1.30
	296	6.30

### *b. Contents of Each Box.*

Box No.	Item	Quantity	Notes
1	Receiver-Transmitter RT-66/GRC, (RT-67/GRC, or RT-68/GRC).	1 ea	RT-66/GRC, RT-67/GRC, and RT-68/GRC for Radio Sets AN/VRC-20, -21, and -22, respectively. PP-109/GR supplied for 12-volt systems; PP-112/GR supplied for 24-volt systems.
	Power Supply PP-109/GR or Power Supply PP-112/GR.	1 ea	
2	Mast Base AB-15/GR. ....	1 ea	Not supplied with Radio Set AN/VRC-21.
	Mast Section MS-116-A. ....	2 ea	
	Mast Section MS-117-A. ....	2 ea	

Box No.	Item	Quantity	Notes
3	Mast Section MS-118-A. ....	2 ea	Not supplied with Radio Set AN/VRC-21.
	Mast Section AB-24/GR. ....	2 ea	Supplied with Radio Set AN/VRC-21 only.
	Adapter UG-273/U. ....	1 ea	
	Adapter UG-306/U. ....	1 ea	
	Special Purpose Cable Assembly CX-1211/U.	1 ea	
	Wire W-142. ....	1 ft	
	Bag CW-206/GR. ....	1 ea	
	Radio Receiver R-108/GRC, R-109/GRC, or R-110/GRC.	1 ea	R-108/GRC, R-109/GRC, and R-110/GRC for Radio Sets AN/VRC-20, -21, and -22, respectively.
	AF Amplifier AM-65/GRC. ....	1 ea	
	Power Supply PP-281/GRC. ....	2 ea	PP-281/GRC supplied for 12-volt systems.
	or		
	Power Supply PP-282/GRC. ....	2 ea	PP-282/GRC supplied for 24-volt systems.
	Case CY-684/GR. ....	1 ea	
	Technical manual (TM 11-642). ....	2 ea	
	Special Purpose Cable WM-46/U. ....	10 ft	
	Control Box C-375/VRC. ....	1 ea	
	Mounting MT-297/GR. ....	1 ea	
	RF Cable Assembly CG-568/U. ....	1 ea	Supplied with Radio Sets AN/VRC-21 and -22 only.
	RF Cable Assembly CG-530/U. ....	1 ea	Not supplied with Radio Set AN/VRC-20.
	Connector and bondnut, Appleton Electric Company Nos. 61007 and BL-50, or equivalent.	1 ea	

## 9. General System Description

*a. Introduction.* The three radio sets have the following items in common: a receiver-transmitter, a receiver, an interphone amplifier, suitable power supplies, a mounting, a control unit, suitable antenna systems, and interconnecting cables. Radio Set AN/VRC-20 (fig. 3) described in *b* below is typical of all the sets discussed in this manual. The nomenclature outlined in paragraph 2, the table of components (par. 6), and figure 27 all indicate the differences between the three radio sets.

*b. Radio Set AN/VRC-20.* Figure 1 shows the major components of Radio Set AN/VRC-20, -21, or -22 connected to simulate an operating installation. In Radio Set AN/VRC-20, Power Supply PP-109/GR or Power Supply PP-112/GR, Receiver-Transmitter RT-66/GRC, Radio Receiver R-108/GRC, and AF Amplifier AM-65/GRC are secured to Mounting MT-297/GR. Power Supply PP-112/GR or PP-109/GR furnishes the operating volt-

ages for the receiver-transmitter. Two Power Supplies PP-282/GRC or PP-281/GRC, one contained within the auxiliary receiver and the other contained within the interphone amplifier, furnish the operating voltages for these units. Mounting MT-297/GR normally is bolted to a vehicular mounting surface. From the mounting, connections are made to the vehicular battery, to the major units supported on the mounting, and to one or more Control Boxes C-375/VRC. Connections to the antenna system are made directly from the panel of the receiver-transmitter (fig. 27).

*c. Radio Sets AN/VRC-21 and -22.* These systems differ from Radio Set AN/VRC-20 in the type of receiver-transmitter, auxiliary receiver, and antenna system used. Radio Set AN/VRC-21 uses Receiver-Transmitter RT-67/GRC and Radio Receiver R-109/GRC; Radio Set AN/VRC-22 uses Receiver-Transmitter RT-68/GRC and Radio Receiver R-110/GRC. For differences in antenna cables and mast sections, see figure 27.



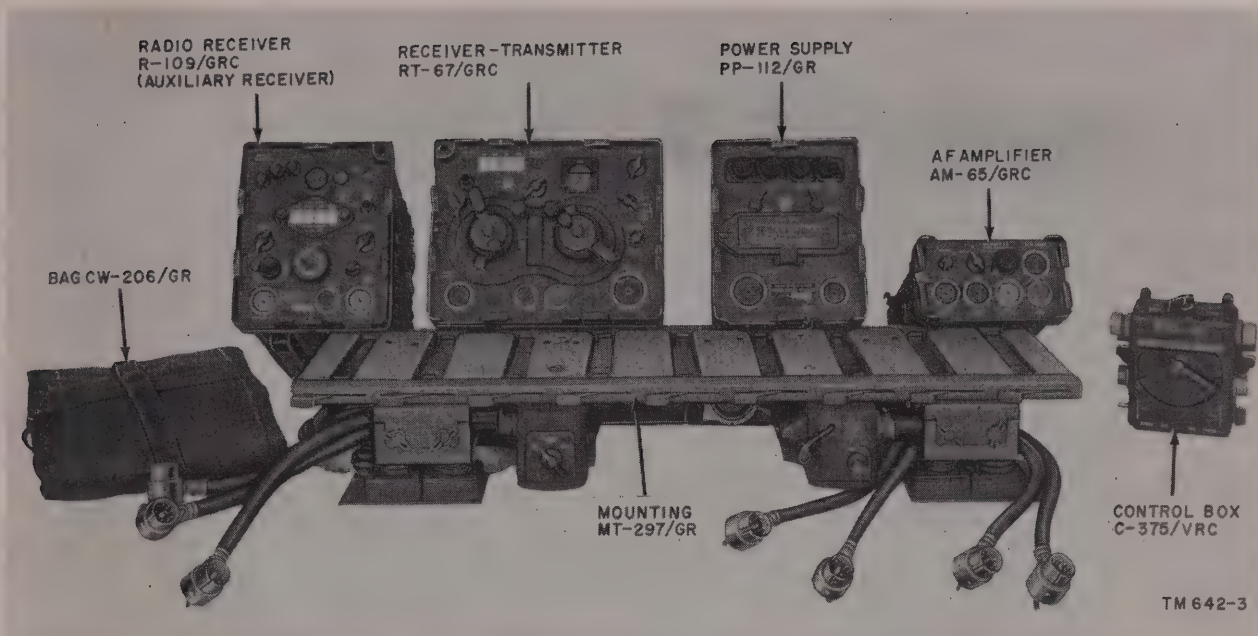


Figure 3. Components of Radio Set AN/VRC-21.

## 10. Receiver-transmitters

a. Receiver-Transmitters RT-66/GRC, RT-67/GRC, and RT-68/GRC are used in Radio Sets AN/VRC-20, -21, and -22, respectively. The receiver-transmitters are very similar in structure, function, and detailed circuit and mechanical arrangement. They differ from one another in their operating frequency ranges and in those components which determine the frequency range. Therefore, Receiver-Transmitter RT-66/GRC (fig. 4) is externally similar to the other receiver-transmitters except for the calibrations of the tuning dial. Characteristics pertinent to system operation are listed in paragraph 5. Complete information on the receiver-transmitters is contained in TM 11-289.

b. Each receiver-transmitter consists of a double-conversion type, superheterodyne f-m receiver and an f-m transmitter which use a common antenna. The tuning mechanism of each receiver-transmitter is detented at every mc and every 100 kc of its range to provide the channel selections indicated in the following chart. To allow rapid selection of any two of the detented channels, a present mechanism is provided (par. 54). To allow continuous tuning between channels, provision also is

Receiver-transmitter	Frequency coverage	No. of channels
RT-66/GRC.....	20 to 27.9 mc	80
RT-67/GRC.....	27 to 38.9 mc	120
RT-68/GRC.....	38 to 54.9 mc	170

made to disengage the 100-kc detent mechanism (par. 55).

c. Panel-mounted audio receptacles are provided for use of a chest set (with headset and microphone), handset, headset, microphone, or loudspeaker.

d. Structurally, the receiver-transmitters are panel-chassis assemblies inclosed in a metal case (fig. 4). The bottom of the case is fitted with channel rails which are used to secure the unit to the vehicular mounting. When the case is removed, the r-f and i-f (intermediate-frequency) chassis assemblies are available at either side of the unit (figs. 52 through 54). All tubes are mounted on these vertical chassis.

e. In vehicular installations, the receiver-transmitter is installed on Mounting MT-297/GR (fig. 9) and is powered by a vehicular power supply, such as Power Supply PP-112/GR. Auxiliary operation of the receiver-transmitter (ch. 6) is possible through use of a battery box and a hand generator.



Figure 4. Receiver-Transmitter RT-66/GRC.

## 11. Receiver-transmitter Power Supply

a. Either Power Supply PP-109/GR or PP-112/GR is used to furnish operating voltages for the receiver-transmitter, depending on whether the vehicular storage battery supplies 12 or 24 volts, respectively. The two units are similar externally (fig. 5). They differ internally only in those circuits necessary to convert the storage battery voltage to the proper operating voltages for the receiver-transmitter. Detailed information on the power supplies is contained in TM 11-5036.

b. The power supplies develop plate, screen, bias, filament, microphone, and relay potentials for the receiver-transmitter. The plate, screen, and bias voltages are developed by vibrator-type power-supply circuits. Input battery voltage is supplied through a POWER IN receptacle on the front panel (fig. 5); all output voltages are available at the POWER OUT receptacle on the front panel.

c. Structurally, the power supply units are panel-chassis assemblies inclosed in a metal case. Channel rails on the bottom of the case permit it to be installed on Mounting MT-

297/GR. When the case is removed (figs. 48 through 51), the replaceable parts on the chassis are accessible.

## 12. Auxiliary Receiver

a. Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC are used as auxiliary receivers in Radio Sets AN/VRC-20, -21, and -22, respectively. The receivers are very similar in structure, function, and detailed circuit and mechanical arrangement; they differ from one another only in their operating frequency ranges and in those components which determine the frequency range. Hence, Radio Receiver R-108/GRC (fig. 6) is similar externally to the other receivers, except for the calibrations of the tuning dial. Receiver characteristics pertinent to system operation are listed in paragraph 5; complete information on the receivers is contained in TM 11-898.

b. Each receiver uses a single-conversion type, superheterodyne f-m circuit with continuous tuning over the ranges indicated in the following chart. A detent mechanism is provided on each receiver for presetting any three



frequencies (par. 56). Note that the receivers duplicate the frequency coverage of the receiver-transmitters with which they are used.

Radio receiver	Frequency coverage
R-108/GRC.....	20 to 28 mc
R-109/GRC.....	27 to 39 mc
R-110/GRC.....	38 to 55 mc

sis assemblies inclosed in a metal case (fig. 6). The bottom of the case is fitted with channel rails which are used to secure the unit to the vehicular mounting (par. 33). When the case is removed, the replaceable parts on the receiver chassis are made accessible (fig. 55).

d. A compartment on the receiver chassis (fig. 55) accommodates a plug-in power-supply unit (Power Supply PP-281/GRC or Power Supply PP-282/GRC).

c. Mechanically, the receivers are panel-chas-

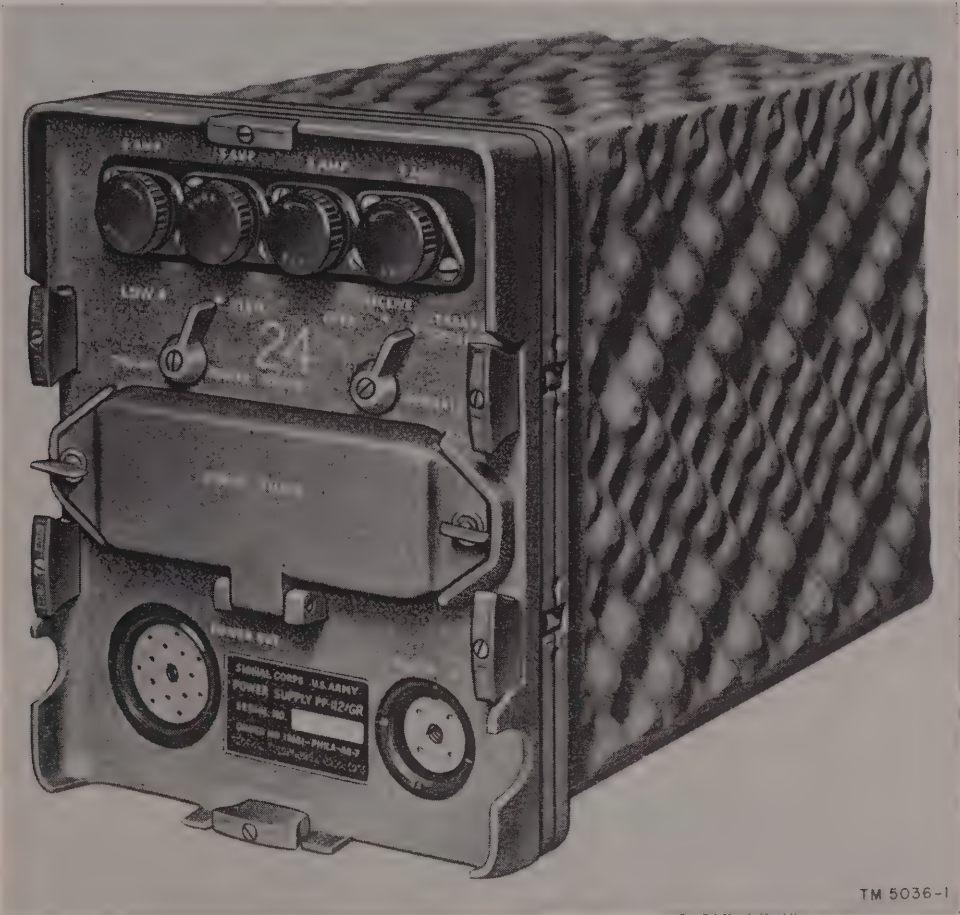


Figure 5. Power Supply PP-112/GRC.

13. Power Supplies PP-281/GRC and PP-282/GRC

Power Supply PP-282/GRC (fig. 7) is used in the auxiliary receiver and in the interphone amplifier for 24-volt installations of the radio sets. These units supply the operating voltages for the auxiliary receiver and the interphone amplifier. Power Supply PP-281/GRC, similar in appearance and general characteristics, is used for 12-volt installations of the radio sets. These are vibrator-type power supplies which

plug into the compartments on the auxiliary receiver and interphone amplifier chassis.

14. AF Amplifier AM-65/GRC

a. AF Amplifiers AM-65/GRC (fig. 8) is a common component of all the radio sets described in this manual. Generally referred to as the interphone amplifier, this unit serves a dual purpose: It provides not only for intercommunication between control boxes but also for monitoring the receiver-transmitter and



Figure 6. Radio Receiver R-108/GRC.

the auxiliary receiver. Detailed information on the amplifier is contained in TM 11-5039.

b. Electrically, the interphone amplifier is a three-channel electronic mixer and an a-f amplifier. The three channels provide a *Set 1 + interphone* output, a *Set 1 + Set 2 + interphone* output, and a *Set 2 + interphone* output. The auxiliary receiver, the receiver-transmitter, and the interphone outputs are available at the *Set 1 + interphone* and at the *Set 1 + Set 2 + interphone* outputs. The interphone output is available at all three output channels. On the *Set 1 + Set 2 + interphone* channel the interphone signal predominates; on the *Set 1 + interphone* channel the signals from the auxiliary receiver, the receiver-transmitter, and the interphone box are of equal strength. Only the interphone signal is available at the *Set 2 + interphone* channel output.

Note. Since Set 2 is not used in this installation, the second and third channels do not carry a Set 2 signal.

c. Mechanically, the interphone amplifier is a panel-chassis assembly inclosed in a metal case. Channel rails on the bottom of the case permit the installation of the unit on Mounting MT-297/GR. When the case is removed (fig. 46), all replaceable parts are accessible.

d. A compartment within the amplifier (fig. 46) accommodates a plug-in power-supply unit (Power Supply PP-281/GRC or PP-282/GRC for 12- and 24-volt operation, respectively) which supplies operating plate and screen voltages for the amplifier.

## 15. Mounting MT-297/GR

a. Mounting MT-297/GR (fig. 9) serves as a support for the major units of the radio sets and as a junction box for interconnecting various units. Figures 1 and 19 demonstrate the dual functions of the mounting.



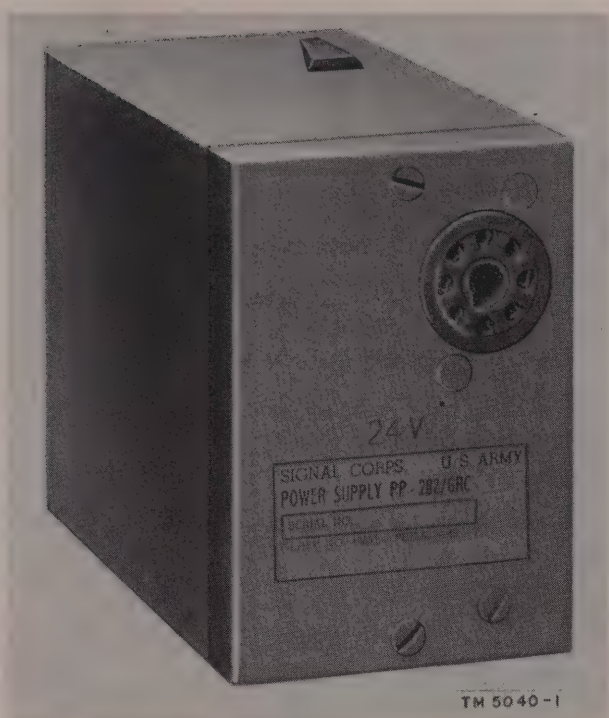


Figure 7. Power Supply PP-282/GRC.

b. At either end of the mounting are two shock-mounted supports which normally are bolted to a vehicular mounting surface. A hinged mounting table is secured to these supports and a junction box is suspended from the under surface of the table near the center of the unit (fig. 9).

c. The mounting table is channeled to accommodate the rails on the bottom of the receiver-

transmitter, the receiver-transmitter power supply, the auxiliary receiver, and the interphone amplifier. Locking levers are provided on the front edge of the mounting table to secure the units on the table.

d. The junction box at the center of the unit contains the terminal boards and electrical circuits which serve to interconnect the units in an operating system (fig. 19). Cables are provided on either side of the junction box to connect the mounting to the vehicular battery and to the major units. Each cable is tagged to facilitate proper interconnection. A receptacle on the rear inner surface of the junction box serves to accommodate Local Control C-434/GRC and to make electrical connections; a lever on the right side of the junction box serves to lock the control unit in the receptacle to effect a watertight connection.

e. Figure 19 shows the mounting table swung back on its hinges and the cover plates removed from the junction box so that access may be had to the interior of the junction box for installation and maintenance purposes.

## 16. Control Box C-375/VRC

a. One or more Control Boxes C-375/VRC (fig. 10) are used in every installation of the radio sets described in this manual. One unit is supplied with the basic radio set; additional units may be supplied in the installation kits (par. 7).

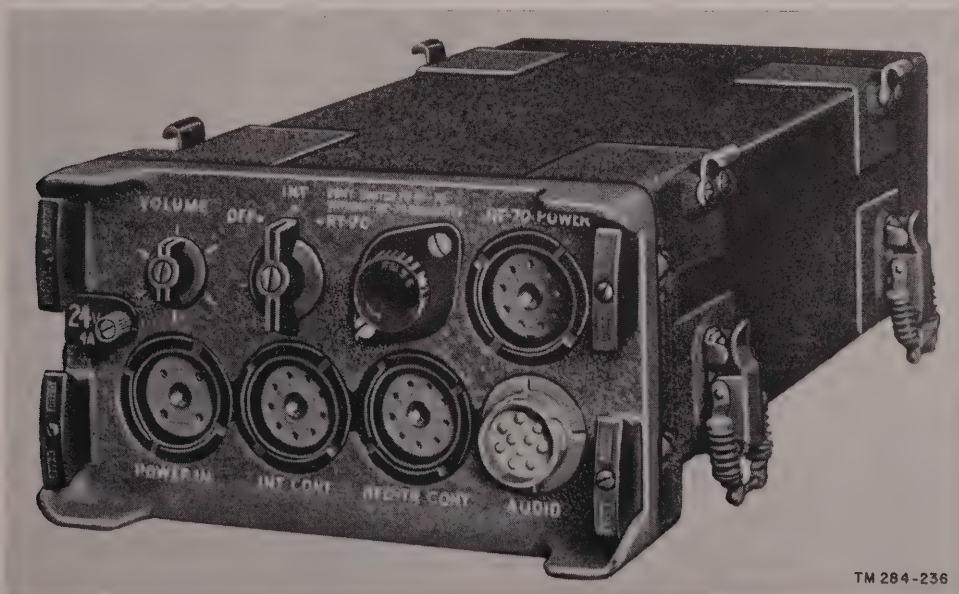
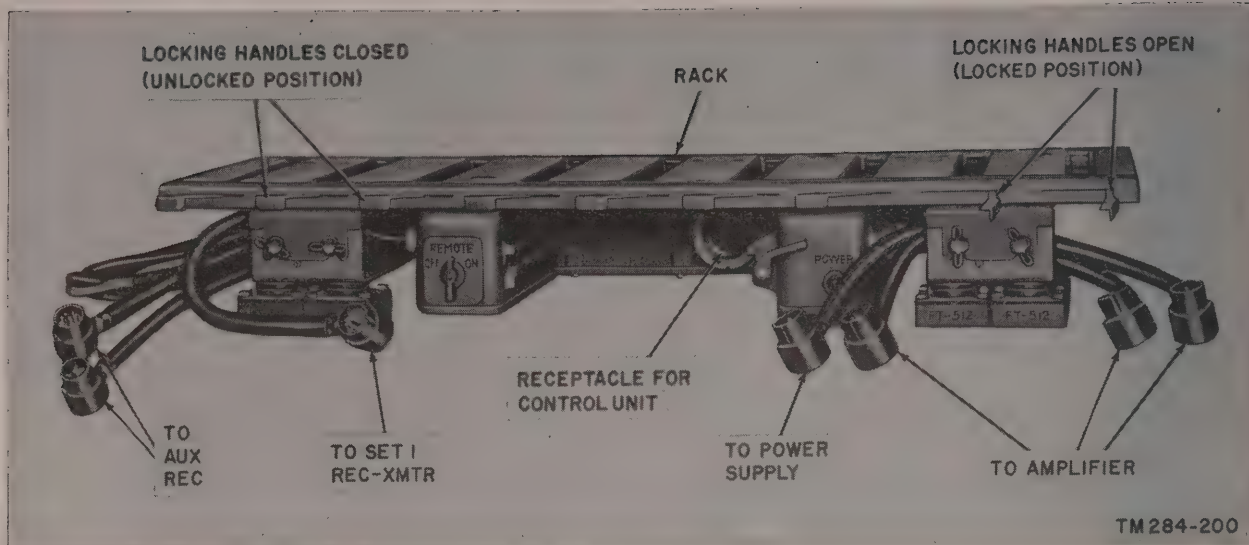


Figure 8. AF Amplifier AM-65/GRC.



TM284-200

Figure 9. Mounting MT-297/GR.

b. Control Box C-375/VRC is a remote junction point and switching unit for push-to-talk control and audio lines to the receiver-transmitter, the interphone amplifier, and the audio line of the auxiliary receiver. Switches on the control box may connect any of these lines to the 10-pin audio connectors on either side of the box (figs. 57 and 58) and to the MIC. and PHONE jacks on the bottom of the box (fig. 58).

c. Normally, the control boxes are installed at some distance from Mounting MT-297/GR (in locations convenient for the driver, gunner, commander, or other operator) and are connected to the mounting either directly or indirectly by means of Special Purpose Cable WM-46/U. Cable entries are provided at either side of the control box (figs. 57 and 58).

## 17. Minor Components

a. The following minor components are illustrated in figure 11:

- (1) Mast Base AB-15/GR.
- (2) Mast Sections MS-116-A, MS-117-A, and MS-118-A.
- (3) Mast Section AB-24/GR.
- (4) Adapters UG-273/U and UG-306/U.
- (5) RF Cable Assembly CG-568/U.
- (6) RF Cable Assembly CG-530/U.
- (7) Special Purpose Cable Assembly CX-1211/U.
- (8) Special Purpose Cable WM-46/U.
- (9) Connector and bondnut, Appleton

Electrical Company No. 61007 and BL-50, or equal.

- (10) Case CY-684/GR.
- (11) Bag CW-206/GR.
- (12) Power Supply PP-282/GRC (two supplied).
- (13) Wire W-142.

*Note.* With the exception of items (9), (10), (11), and (12), all of the above components are represented functionally on the system cordage diagram (fig. 27).

b. The connector and bondnut are used for connecting the power cable of the radio set (W-8 on fig. 27) to the vehicular power terminal box. The connector is of the feedthrough-type, and the bondnut locks the connector in place.

c. Case CY-684/GR is a metal box provided for the storage of running spares. Compartments are provided for tubes, lamps, fuses, and other replaceable parts. The case will not accommodate all of the running spares which are supplied with the various units (par. 19), but will accommodate some of each type.

d. Bag CW-206/GR is provided for the storage of spare antenna mast sections, Case CY-684/GR, audio accessories (not in use), and technical manual.

## 18. Audio Accessories

a. *Type.* Audio accessories for operating the radio sets are supplied in the installation units. They vary in type and number according to the



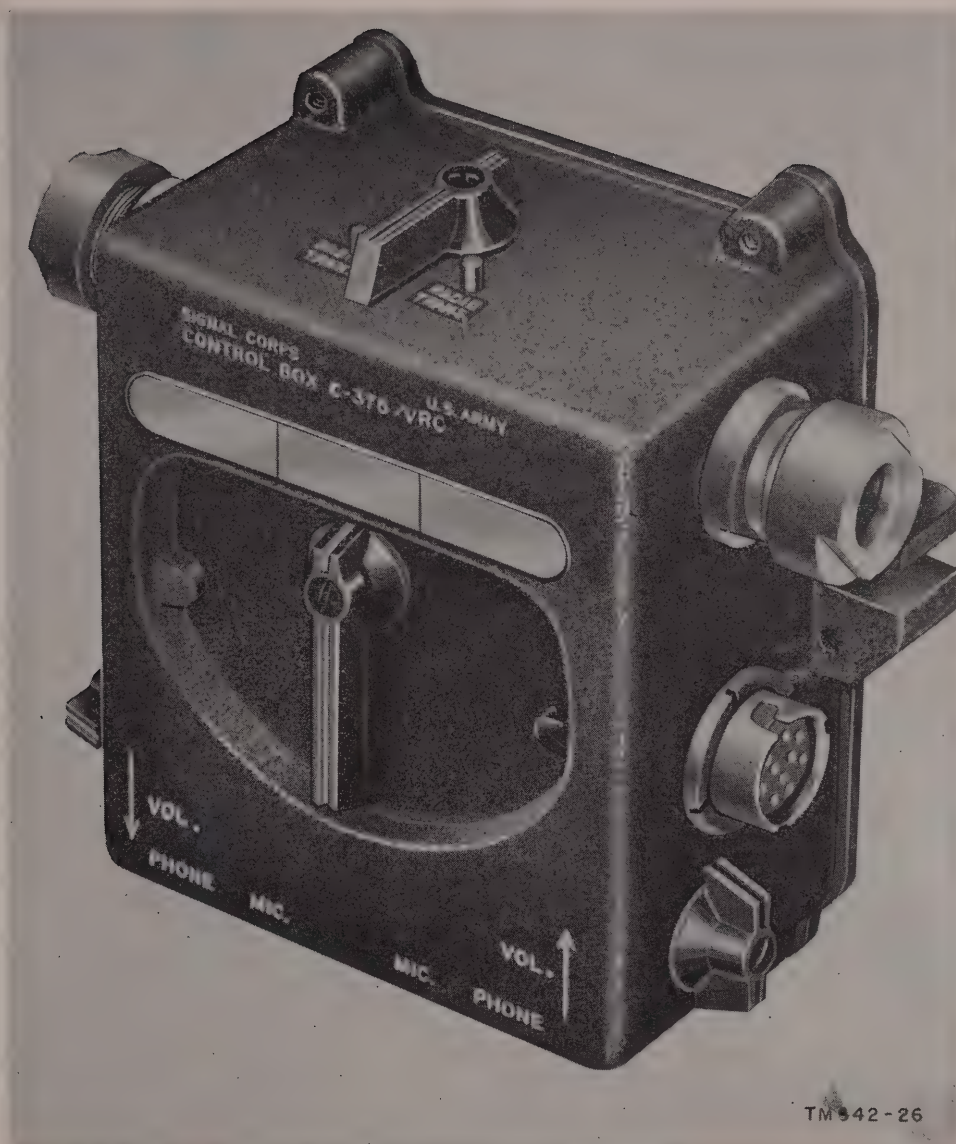


Figure 10. Control Box C-375/VRC.

type of vehicular installation. Some or all of the following items may be supplied:

- (1) Chest Set Group AN/GSA-6 and Headset-Microphone H-63/U.
- (2) Dynamic Loudspeaker LS-166/U.
- (3) Handset H-33/PT.
- (4) Microphone M-29/U.
- (5) Headset Navy type CW-49507 and Headset Cord CX-1334/U.

*Note.* The audio accessories listed above are the only types which can be connected to the 10-pin audio connectors on the radio sets. Control Box C-375/VRC is the only unit equipped with jacks which will accommodate substitute accessories (*h* below).

*b. Chest Set Group AN/GSA-6.* Chest Set Group AN/GSA-6 (fig. 12), in conjunction with Headset-Microphone H-63/U (*c* below), is the audio accessory most commonly used with the radio sets. This chest set is superior to the earlier Chest Set TD-4. It may connect to any audio connector in the radio set. Also, with this chest set, the RADIO TRANS. switch on Control Box C-375/VRC may be locked at RADIO TRANS. and still allow an operator to transmit or speak over the interphone without operating the RADIO TRANS. switch. The chest set group consists of a chest-mounting switch box and a 5-foot cord which terminates in an 8-contact connector on one end and



Figure 11. Minor components of Radio Set AN/WRC-20, -21, and -22.

a 10-pin audio connector on the other. The connector mates with a receptacle on one end of the switch box and provides a quick-disconnect feature for the chest set. The audio connector will mate with any of the 10-pin receptacles on the control units or on the receiver-transmitter. Two plugs provided on the switch box will mate with the jacks on Headset-Microphone H-63/U. Two push-to-talk buttons are provided on one side of the switch box; a push-button RADIO-INT switch is provided on the other side of the box. Electrically, the push-to-talk buttons are identical; however, one provides momentary contact and the other locks in position. When desired, the lock-on button can be disabled by means of an internal adjustment (fig. 28). The RADIO-INT switch

is a momentary-type switch normally in the INT position. An internal adjustment is provided (fig. 28) to lock the switch in either the RADIO or INT position.

c. *Headset-Microphone H-63/U*. Headset-Microphone H-63/U (fig. 13) consists of two series-connected 300-ohm receivers and a 100-ohm microphone. The microphone is mounted on an adjustable boom attached to the receiver headband. Two 14-inch conductors from the microphone and headset are terminated in two-pin and three-pin jacks, respectively. These jacks will mate with the plugs on Chest Set Group AN/GSA-6.

d. *Dynamic Loudspeaker LS-166/U*. Dynamic Loudspeaker LS-166/U (fig. 14) is a 4-inch permanent-magnet dynamic loudspeaker with



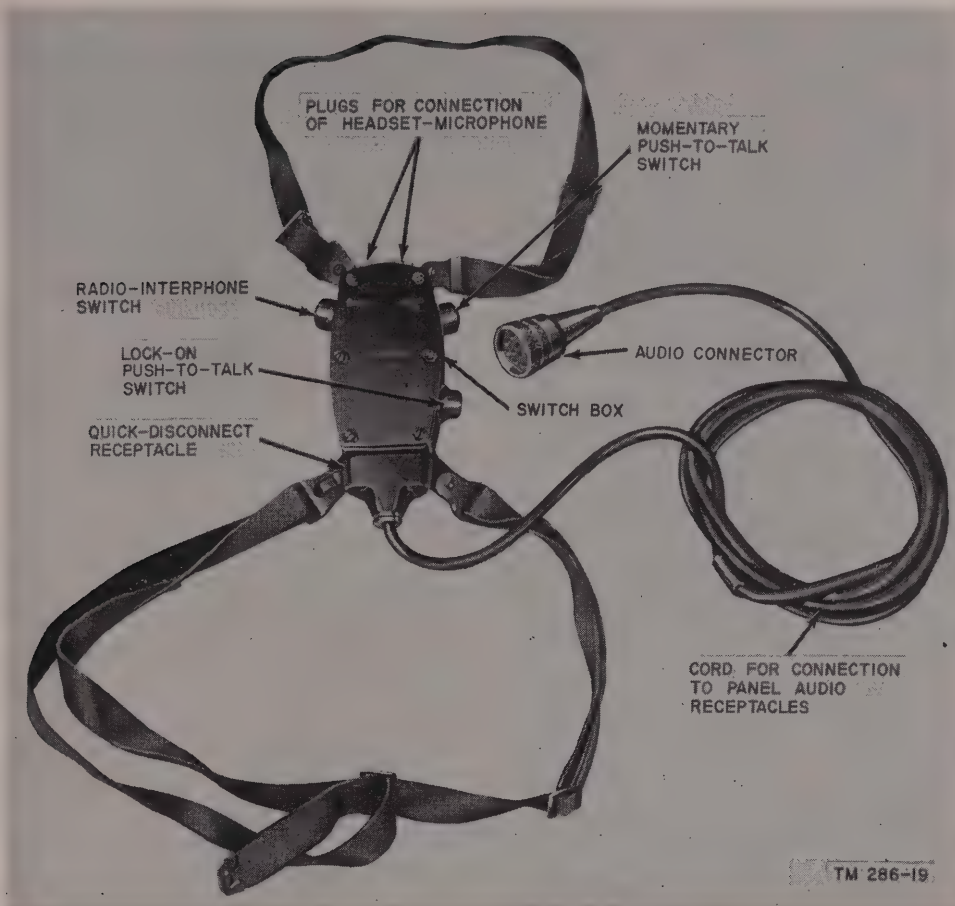


Figure 12. Chest Set Group AN/GSA-6.

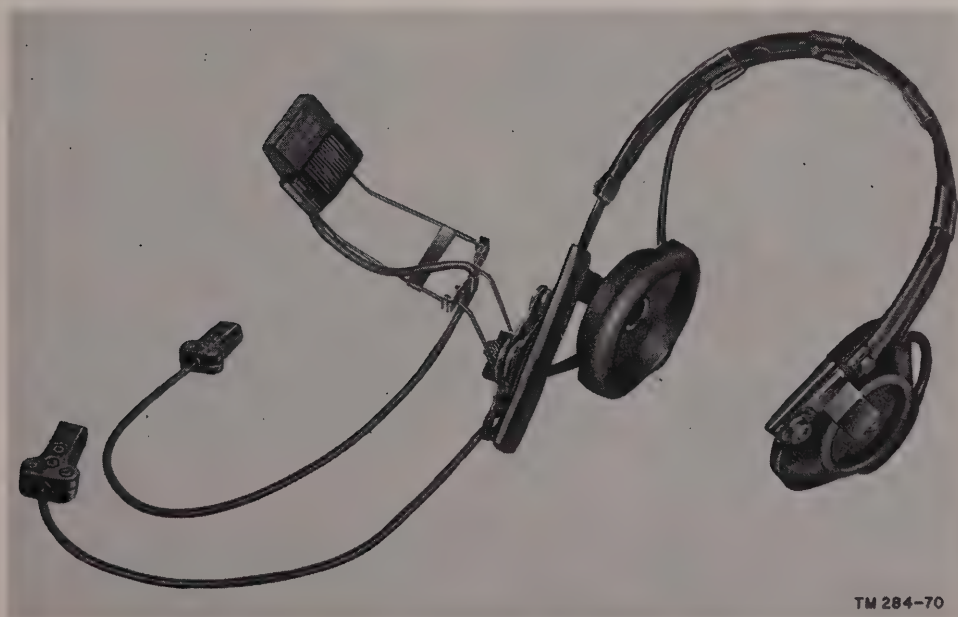


Figure 13. Headset-Microphone H-63/U.

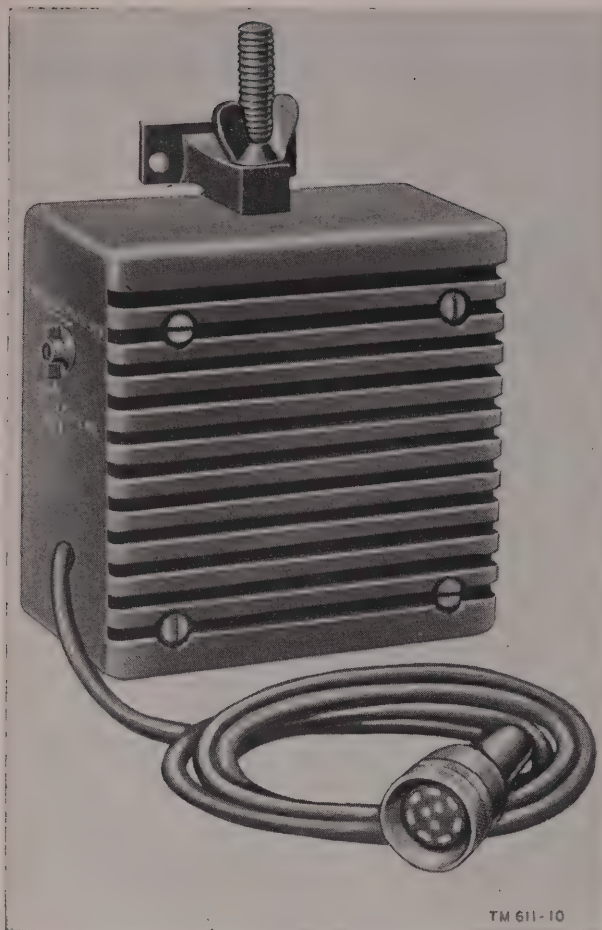


Figure 14. Dynamic Loudspeaker LS-166/U.

a voice-coil impedance of 8 ohms, and a matching transformer which provides a 600-ohm input impedance. A 5-foot cord, terminated in a 10-pin audio connector, is provided for connecting the speaker to the audio receptacles wired for loudspeaker or telephone operation. A two-

position switch on the side of the speaker may be used to switch the units from speaker to telephone output. A universal-type clamp is provided on the speaker case for mounting purposes.

e. *Handset H-33PT.* Handset H-33/PT (fig. 15) is a combination microphone and receiver with a push-to-talk switch and a connecting cord. Microphone impedance is 40 ohms; receiver impedance is 300 ohms. The push-to-talk switch provided is a double-pole single-throw switch. The cord is 5 feet long and is terminated in a 10-pin audio connector which will mate with the audio receptacles on the receiver-transmitter or with the audio receptacles on either of the control units.

f. *Microphone M-29/U.* Microphone M-29/U (fig. 16) consists of a 100-ohm carbon-microphone element in a plastic case with a push-to-talk switch and connecting cord attached. The push-to-talk switch is a double-pole single-throw switch. The connecting cord is 5 feet long and terminates in a 10-pin audio connector which will mate with the receptacles on the receiver-transmitter or with the audio receptacles on either of the control units.

g. *Headset Navy Type CW-49507 and Headset Cord CX-1334/U.* Headset Navy Type CW-49507 (fig. 17) consists of two series-connected 300-ohm receivers. A 14-inch cord is connected to the receivers and is terminated in Plug PL-54. The plug will mate with jack J-26, on one end of Headset Cord CX-1334/U. Headset Cord CX-1334/U is 5 feet long. It is terminated in a 10-pin audio connector, and serves to connect the headset to the audio receptacles on the

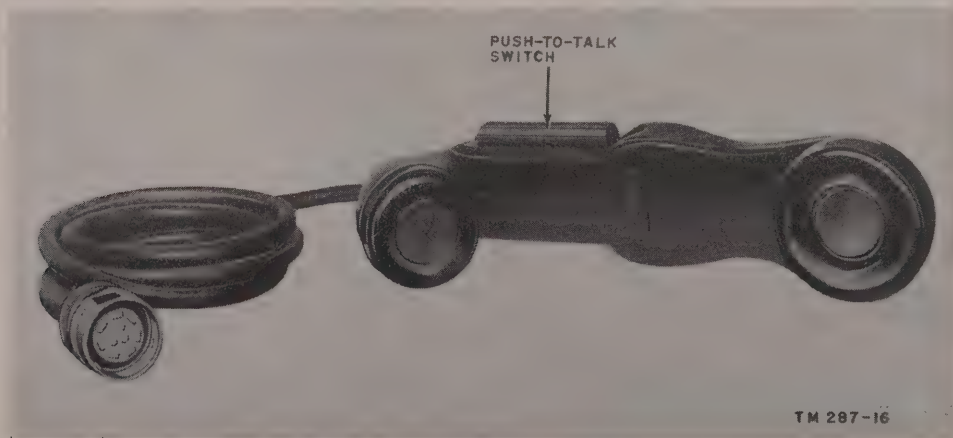


Figure 15. Handset H-33/PT.



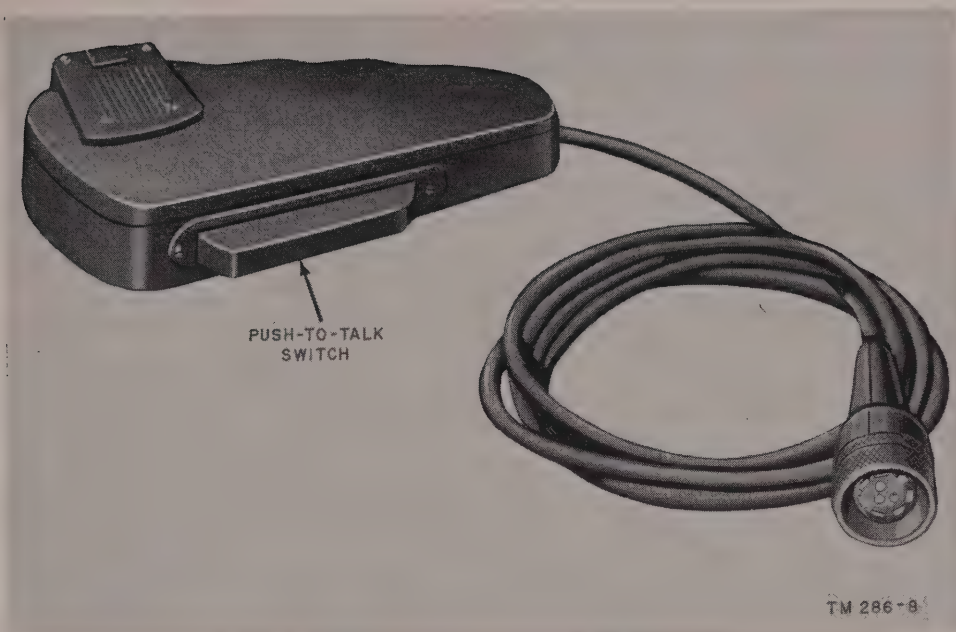


Figure 16. Microphone M-29/U.

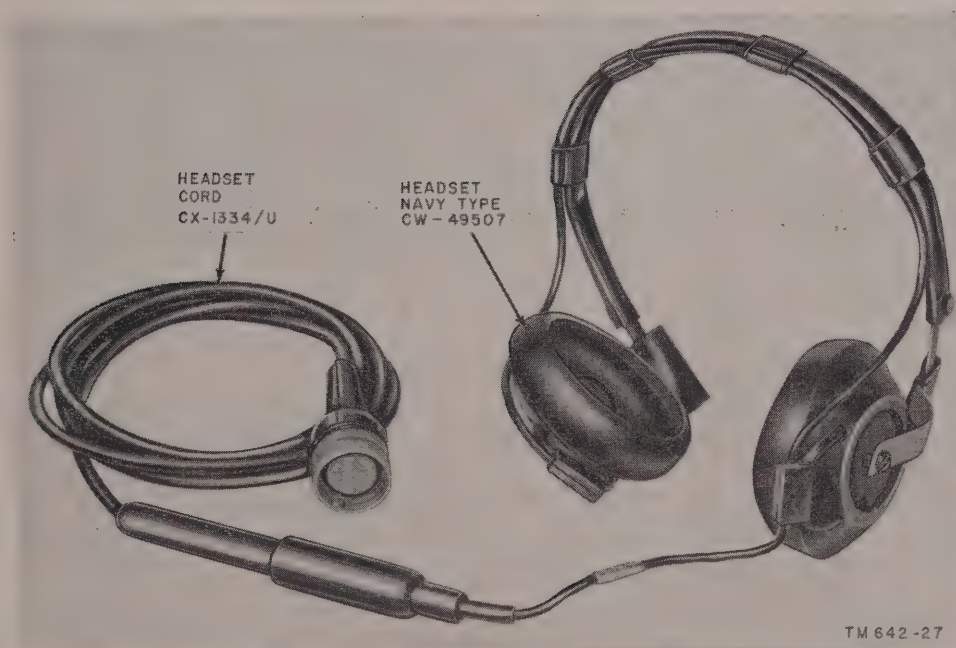


Figure 17. Headset Navy Type CW-49507 and Headset Cord CX-1334/U.

receiver-transmitter or to the audio receptacles on either of the control units.

*Note.* The audio accessories should not be used indiscriminately on any of the units, even though it is possible to connect them physically. Refer to chapter 3 for correct usage of the audio accessories.

*h. Substitute Accessories.* The substitute accessories listed in the following chart may be used only if absolutely necessary. Performance will be inefficient, however, because of impedance mismatches. Operating facilities will be

confined solely to Control Box C-375/VRC.

Standard item	Substitute item
Chest Set Group	Chest Set TD-4 or Cords
AN/GSA-6. ....	CD-307-A and CD-318.
Headset-Microphone	Headset H-16/U and Micro-
H-63/U. ....	phone T-45 or Headset
	HS-30 with Cord CD-933
	and Microphone T-45.
Headset Navy type	Headset H-16/U or Headset
CW-49507. ....	HS-30 with Cord CD-933.
Headset Cord	
CX-1334/U. ....	Cord CD-307-A.
Microphone M-29/U. ..	Microphone T-17.
Dynamic Loudspeaker	
LS-166/U. ....	None.
Handset H-33/PT. ....	None.

## 19. Running Spares

Running spares for normally expendable items, such as tubes, fuses, and vibrators, are supplied with some of the system components. The spares supplied are listed in *a* through *e* below.

*Note.* Case CY-684/GR, provided for carrying the spare parts, is not ample for carrying all of the parts supplied; therefore, it will be necessary to make a selection of those parts most likely to be needed.

*a. Spare Parts for Receiver-Transmitters RT-66/GRC, RT-67/GRC, and RT-68/GRC.* The spare parts supplied for each of these components are identical.

- 2 tubes, electron, type 1A3.
- 2 tubes, electron, type 1AE4.
- 2 tubes, electron, type 1L4.
- 4 tubes, electron, type 1R5.
- 1 tube, electron, type 1S5.
- 6 tubes, electron, type 1U4.
- 3 tubes, electron, type 2E24.
- 1 tube, electron, type 3A4.
- 5 tubes, electron, type 3A5.
- 2 tubes, electron, type 3B4.
- 6 tubes, electron, type 3Q4.
- 2 tubes, electron, type 6AK5:

*b. Spare Parts for Power Supplies PP-109/-GR and PP-112/GR.*

- (1) *Power Supply PP-109/GR.*
  - 2 fuses, cartridge, type AGU, 5-ampere.
  - 2 fuses, cartridge, type AGU, 10-ampere.

- 1 relay, thermal (K-1, K-2).
- 2 tubes, ballast (R-24, R-25, R-31).
- 1 tube, electron, type 1007.
- 2 tubes, electron, type OB2.
- 2 tubes, electron, type OA2.
- 3 vibrators, 6-volt (E-1, E-2, E-3).

(2) *Power Supply PP-112/GR.*

- 3 fuses, cartridge, type AGU, 5-ampere.
- 1 fuse, cartridge, type AGU, 3-ampere.
- 1 relay, thermal (K-1, K-2).
- 3 tubes, ballast (R-24, R-25, R-31, R-37, R-38, R-40).
- 1 tube, electron, type 1007.
- 2 tubes, electron, type OB2.
- 2 tubes, electron, type OA2.
- 3 vibrators, 24-volt (E-1, E-2, E-3).

*c. Spare Parts for Radio Receivers R-108/-GRC, R-109/GRC, and R-110/GRC.* Spare parts supplied for each of these receivers are identical.

- 1 fuse, cartridge, 4-ampere.
- 1 relay, thermal, SPST (K-1).
- 1 tube, ballast (R-59).
- 2 tubes, electron, type OB2.
- 1 tube, electron, type 1A3.
- 1 tube, electron, type 1L4.
- 2 tubes, electron, type 1S5.
- 6 tubes, electron, type 1U4.
- 4 tubes, electron, type 3A5.
- 3 tubes, electron, type 3Q4.
- 4 tubes, electron, type 6AK5.

*d. Spare Parts for AF Amplifier AM-65/-GRC.*

- 1 fuse, cartridge, 4-ampere (F-1).
- 1 fuse, cartridge, 10-ampere (F-1).
- 1 tube, ballast (R-52).
- 1 relay, thermal (K-1).
- 2 tubes, electron, type 6AK6.
- 3 tubes, electron, type 12AU7.
- 2 tubes, electron, type OB2.

*e. Spare Parts for Power Supplies PP-281/-GRC and PP-282/GRC.*

- (1) *Power Supply PP-281/GRC.* 2 vibrators, plug-in type, 6-volt input (supplied with each power supply).
- (2) *Power Supply PP-282/GRC.* 2 vibrators, plug-in type, 24-volt input (supplied with each power supply).



## CHAPTER 2

### INSTALLATION

---

#### Section I. INTRODUCTION

##### 20. General

The installation instructions included in this manual are generalized to make them applicable to any installation. The variety of vehicles in which the radio sets may be installed necessarily limits the specificity of such details as the exact location of units, the routing of cables, the placement of antennas, etc. Required clearances, interconnection data, and all other essential information are included. For specific details pertinent to particular vehicles, refer to the installation instructions supplied with the installation units for the vehicles.

##### 21. General Unpacking Instructions

Take the usual precautions against damage

to the equipment during the unpacking procedure. Observe the following whenever possible:

*a.* Unless instructions are given to the contrary, unpack the equipment as required in the order described. Do not unpack all boxes simultaneously as that may complicate any possible division of labor.

*b.* As each box is unpacked, check its contents against the master packing slip.

*c.* Use cutters to clip metal bands.

*d.* Do not pry off the tops or sides of boxes; use a nail puller to remove the nails; then lift off the sides and/or the tops of boxes.

*e.* Save boxes, containers, and other packaging material, if practicable, for possible use for storage or reshipment.

#### Section II. VEHICULAR INSTALLATION DETAILS.

*Note.* Vehicular installation procedures are those which involve modification of the vehicle (for example, the drilling of holes) or some special technique peculiar to a type of vehicle (for example, the routing of cables).

##### 22. Unpacking

The material comprising the installation unit and the material contained in box 3 of the basic unit (par. 8) are required for the vehicular installation details. Unpack the installation unit and box 3 of the basic unit, observing the general precautions noted in paragraph 21.

##### 23. Mounting MT-297/GR

*a.* Locate and secure Mounting MT-297/GR in place according to instructions for the particular vehicle. Allow the minimum clearances as indicated in figure 18. Complete all external connections.

*b.* Loosen the four wingnut fasteners which hold the mounting table firmly against the shock mounts. Swing the mounting table back on its hinges so that the junction box is acces-

sible. Remove the three cover plates from the junction box (fig. 19).

*c.* If the vehicular supply is 12 volts, connect jumpers between terminals 14 and 15, 15 and 16, and 17 and 18. For 24-volt operation, these jumpers are not required.

*d.* Prepare one end of the 10-foot length of Special Purpose Cable WM-46/U in accordance with instructions given in figure 20.

*e.* Loosen the bondnut on the cable clamp at one of the unused cable entries on the right-hand side of the junction box (fig. 19). Remove the nut, metal ring, and rubber washer from the cable clamp and slip them over the prepared end of the cable in the same order (nut, ring, and washer). (The rubber plug, located in the cable entry, is for waterproofing an unused entry; it will not be re-required in the final assembly.)

f. Insert the prepared end of the cable through the cable entry and solder the individual conductors to the terminals of terminal board E-6 in the mounting (fig. 19); observe the color coding indicated in figure 21. The cable should be inserted until the outer insulation protrudes on the inside of the junction box. Allow sufficient slack for all terminal connections.

g. When the connections are complete, tighten the bondnut on the cable clamp.

h. Before replacing the covers on the junction box, check the tightness of solderless connectors E-1, E-3, E-4, E-9, and E-12 (fig. 19). Cable compression can cause these connectors to become loose over a period of time. Also check to see that fuse F-I is seated securely.

i. Replace the covers on the junction box.

j. Spot and drill the eight mounting holes in accordance with the dimensional data (fig. 18). Bolt the mounting to the vehicle.

k. Swing the mounting table back to its normal position and tighten the wingnut fasteners at each end of the table. Make sure that the cables from the mounting are routed

in accordance with the layout shown on figure 27.

l. Route the loose end of Special Purpose Cable WM-46/U in accordance with instructions outlined in the installation instructions supplied with the vehicular installation unit (Although the units to be interconnected are Mounting MT-297/GR and Control Box C-375/VRC, vehicular layout will determine whether a direct connection will be made or whether slip rings and/or junction boxes will intervene (par. 24b).

m. Turn the power switch of the mounting to the OFF position. *Do not turn this switch to ON throughout the entire installation procedure.*

n. Connect the battery cable (W-8 in fig. 19) in accordance with instructions furnished with the installation unit. Generally, the cable will connect to a vehicular junction box rather than directly to the battery. Use the connector and bondnut supplied with the basic unit to secure the cable at its point of entry into the junction box. Leave enough slack to allow the mounting table to be swung back without straining the cable.

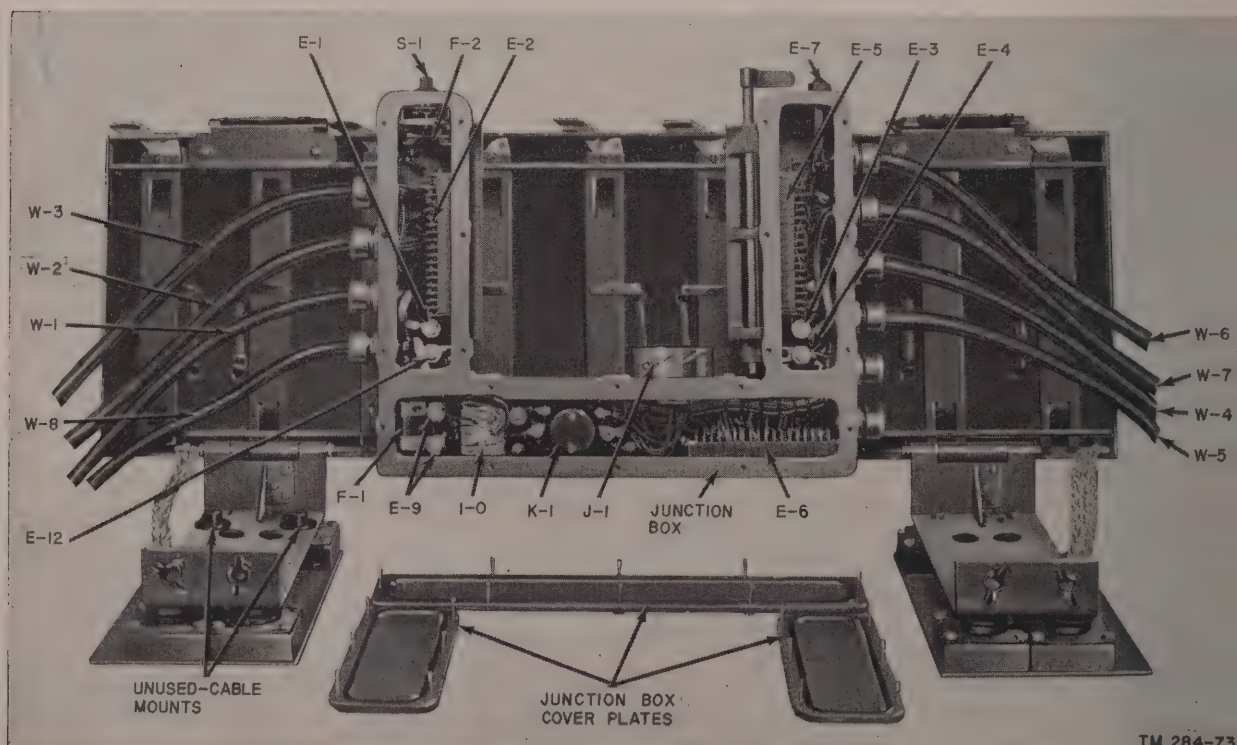
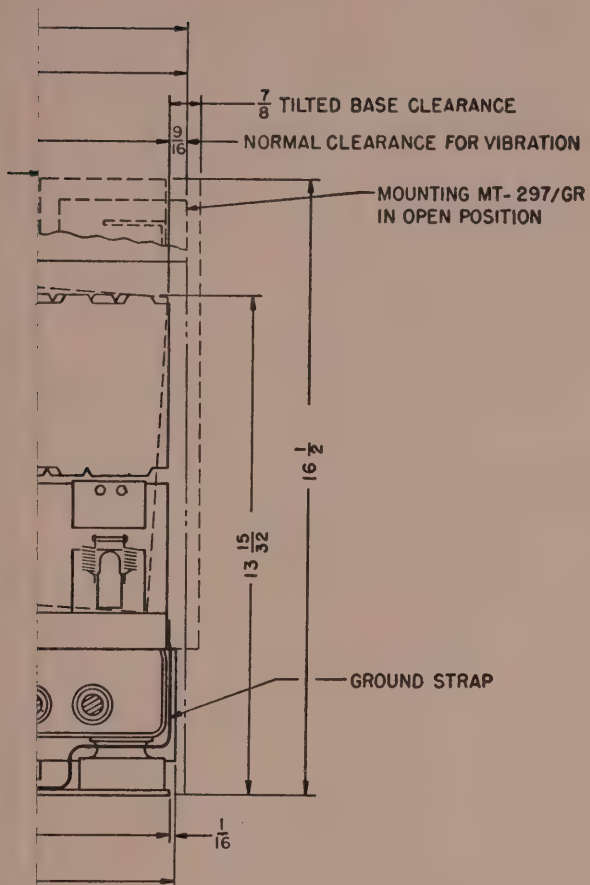


Figure 19. Mounting MT-297/GR, open view.





CE REQUIRED FOR INSTALLATION.  
 PT CLEAR FOR ACCESS TO CONTROLS.  
 MUST BE PROVIDED AT ALL JACKS TO  
 UG CONNECTOR U-77/U.

.343 DIA  
 8 HOLES

VER SUPPLY N RECEIVER (AMPLIFIER)	RF CABLE ASSEMBLY
282/GRC **	CG-568/U
	CG-530/U

GRC  
 /GRC

f. Insert the prepared end of the cable through the cable entry and solder the individual conductors to the terminals of terminal board E-6 in the mounting (fig. 19); observe the color coding indicated in figure 21. The cable should be inserted until the outer insulation protrudes on the inside of the junction box. Allow sufficient slack for all terminal connections.

g. When the connections are complete, tighten the bondnut on the cable clamp.

h. Before replacing the covers on the junction box, check the tightness of solderless connectors E-1, E-3, E-4, E-9, and E-12 (fig. 19). Cable compression can cause these connectors to become loose over a period of time. Also check to see that fuse F-I is seated securely.

i. Replace the covers on the junction box.

j. Spot and drill the eight mounting holes in accordance with the dimensional data (fig. 18). Bolt the mounting to the vehicle.

k. Swing the mounting table back to its normal position and tighten the wingnut fasteners at each end of the table. Make sure that the cables from the mounting are routed

in accordance with the layout shown on figure 27.

l. Route the loose end of Special Purpose Cable WM-46/U in accordance with instructions outlined in the installation instructions supplied with the vehicular installation unit. (Although the units to be interconnected are Mounting MT-297/GR and Control Box C-375/VRC, vehicular layout will determine whether a direct connection will be made or whether slip rings and/or junction boxes will intervene (par. 24b).

m. Turn the power switch of the mounting to the OFF position. *Do not turn this switch to ON throughout the entire installation procedure.*

n. Connect the battery cable (W-8 in fig. 19) in accordance with instructions furnished with the installation unit. Generally, the cable will connect to a vehicular junction box rather than directly to the battery. Use the connector and bondnut supplied with the basic unit to secure the cable at its point of entry into the junction box. Leave enough slack to allow the mounting table to be swung back without straining the cable.

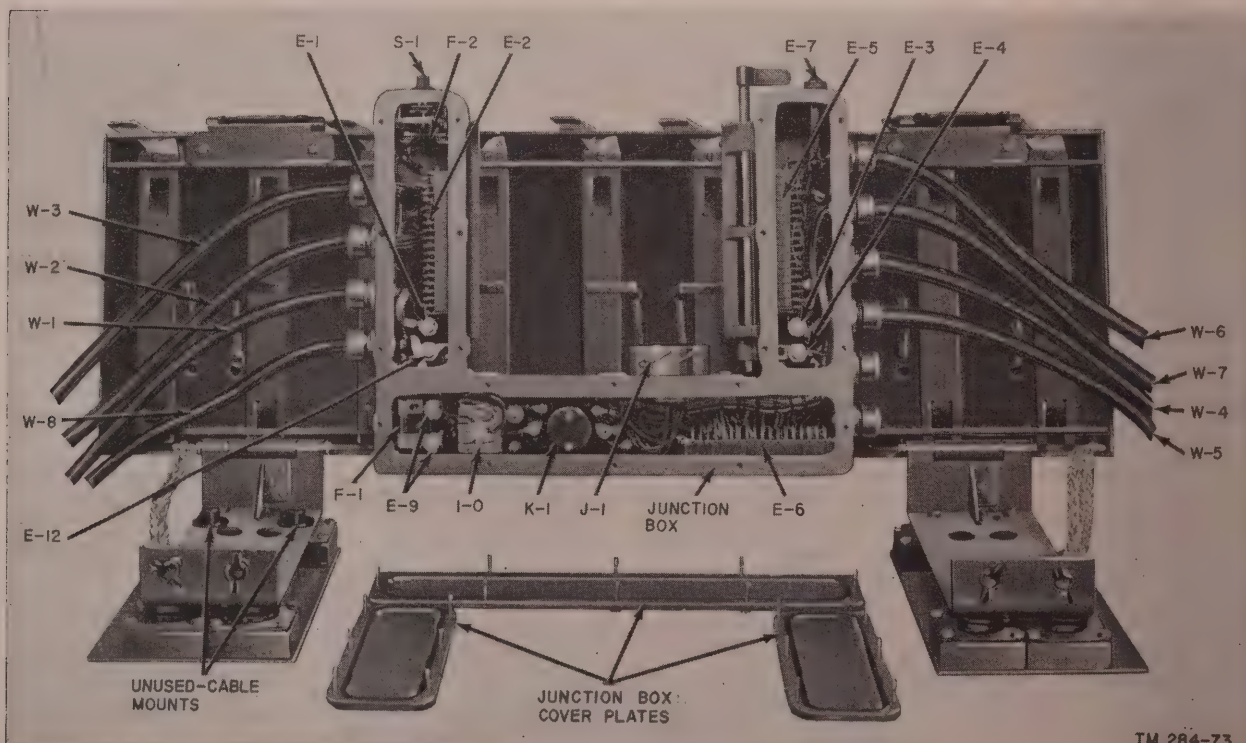


Figure 19. Mounting MT-297/GR, open view.



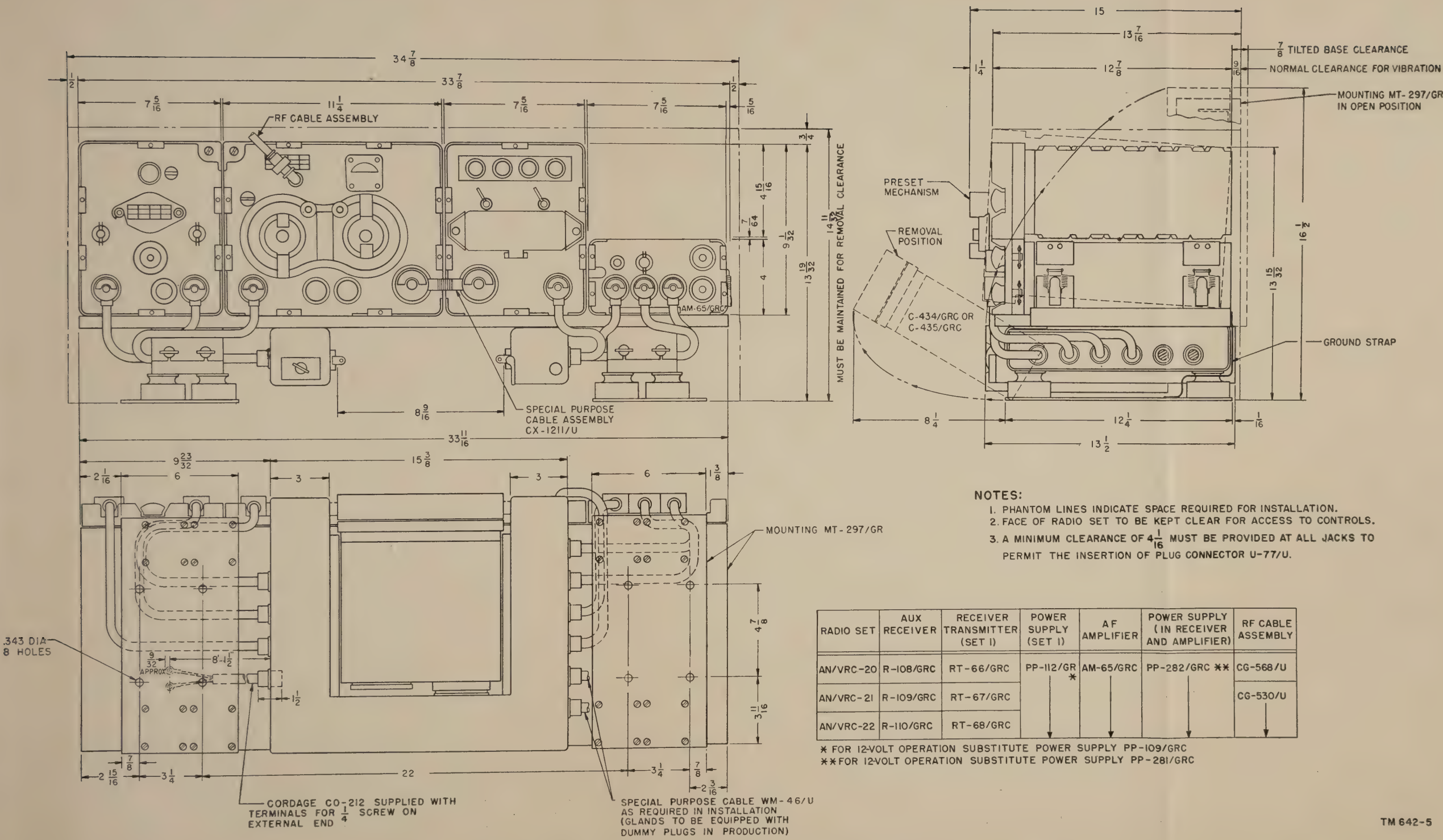


Figure 18. Radio Sets AN/VRC-20, -21, and -22, outline drawing.





## 24. Control Box C-375/VRC

One or more Control Boxes C-375/VRC may be supplied in the installation units in addition to the box supplied with the basic unit. The boxes must be located, mounted, and then interconnected with Mounting MT-297/GR.

a. Spot the location of the control boxes, and drill the mounting holes. The exact locations will vary from vehicle to vehicle and must be determined from the specific instructions supplied with the installation unit. In all cases, minimum clearances of  $2\frac{1}{2}$ , 4, and  $3\frac{3}{4}$  inches should be allowed on the top, the bottom, and the sides, respectively. Before mounting the units, make the connections described for each unit (*b* and *c* below).

b. Remove the cover from the control box, remove the bondnut, ring, and washer from one of the cable clamps (H1 or H2) at the side of the box, and slip the nut, ring, and washer over the loose end of Special Purpose Cable WM-46/U. (This may be the other end of the cable connected to Mounting MT-297/GR; more commonly, it will be an extension of this cable from a vehicular junction box or another Control Box C-375/VRC. In all cases, the cable end should be prepared in accordance with instructions shown in fig. 20.) The waterproof plugs found in the cable entries should be saved if practicable.

c. Insert the prepared end of the cable through the cable entry, and solder the individual conductors to the unused terminals of terminal board E-2 in the control box (fig. 23), observing the color coding shown in figure 21. If the color coding is different, a continuity check should be made to determine that similarly numbered terminals in the mounting and control box are interconnected.

d. When connections are complete, tighten the cable clamp, replace the cover, and mount the units in place, using the hardware provided in the bag attached to each control box.

e. On the composition strips above the selector switch on the panel of each control box, write the following designations from left to right, respectively: SET 1 + AUX REC + INT, SET 1 + AUX REC + INT, and INT.

## 25. Routing Antenna Cables

The antenna cable is connected from the re-

ceiver-transmitter panel to the antenna mast bases. While actual connections cannot be made at this time, provisions must be made for routing the cables. RF Cable Assembly CG-568/U is provided for the receiver-transmitter with Radio Sets AN/VRC-20, while Radio Sets AN/VRC-21 and -22 utilize RF Cable Assembly CG-530/U.

a. If the antenna cable is to run free (without clamping) between the panel of the receiver-transmitter and the antenna mast base, store the cable with audio accessories (par. 27), and connect it after the units have been installed on the mounting (par. 34).

b. If holes must be drilled in the vehicle, or any other vehicular modification must be made to route the antenna cables, follow the instructions supplied in the installation unit.

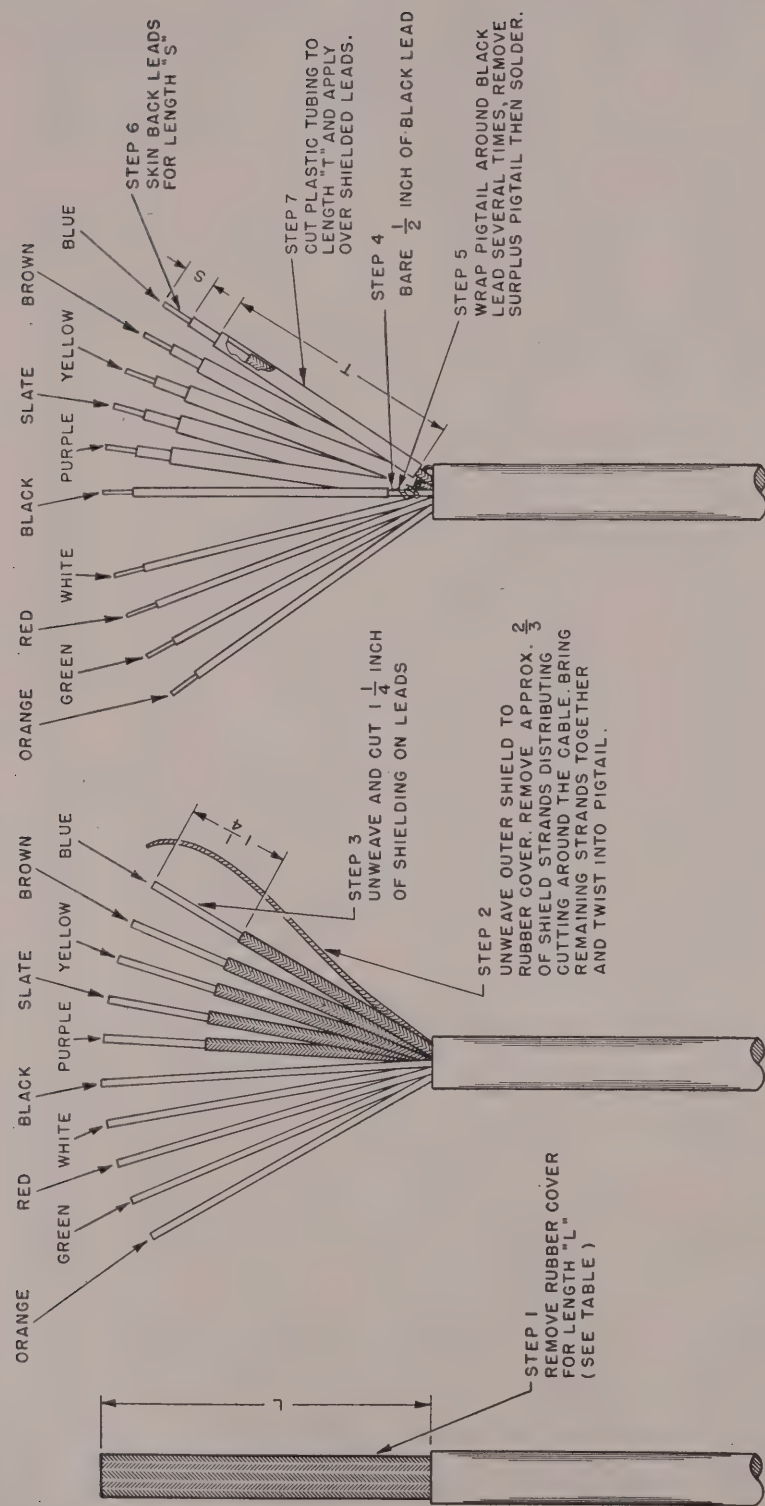
c. If the antenna cables are to be clamped to the vehicle, follow the instructions supplied in the installation unit. When a particular installation calls for the use of Adapter UG-306/U (supplied in the installation units), connect the adapter to the end of the cable which will connect to the mast base.

*Note.* In most cases, the 50-inch antenna cables supplied with the basic units will be sufficiently long. Where a longer length is required, the cable and connectors will be supplied in the installation units. If the connectors are not already assembled to the cable, terminate the cables in accordance with instructions given in figures 24 and 25. *Do not choose lengths at random; use only the length specified in the installation instructions.*

## 26. Vehicular Provisions for Antenna Mast Base

a. Any drilling, installation of mounting brackets, and other vehicular details which are necessary for installing the antenna mast base should be made at this time. The location of the mast and the mounting provisions are different for each type of vehicle, and necessary instructions will be supplied with the vehicular installation unit.

b. Because it is possible, in some instances, that the remaining installation procedures will not be completed until after the vehicle has been shipped to a different depot or organizational unit, actual mounting of the antenna mast bases is not included as a vehicular installation detail. (Its installation might complicate the shipment of the vehicle.) Whether the entire installation is carried through to com-



COMPONENT	LENGTH "L"	LENGTH "S"	LENGTH "T"
CONTROL BOX C-375/VRC	4	$\frac{3}{8}$	$3\frac{3}{8}$
MOUNTINGS MT-297/GR, MT-298/GR, MT-299/GR, MT-300/GR	6	$\frac{3}{8}$	$5\frac{3}{8}$
TERMINAL BOX SC-D-5319	6	$\frac{3}{8}$	$5\frac{3}{8}$
TURRET TERMINAL BOX IN MEDIUM TANK M46	10	$\frac{3}{8}$	$9\frac{3}{8}$
BENDIX - SCINTILLA CONNECTOR SIZE 28 SHELL	$1\frac{3}{8}$	$\frac{5}{16}$	NOT USED
BENDIX - SCINTILLA CONNECTOR SIZE 22 SHELL	$1\frac{1}{4}$	$\frac{1}{4}$	NOT USED

Figure 20. Preparation of Special Purpose Cable WM-46/U.



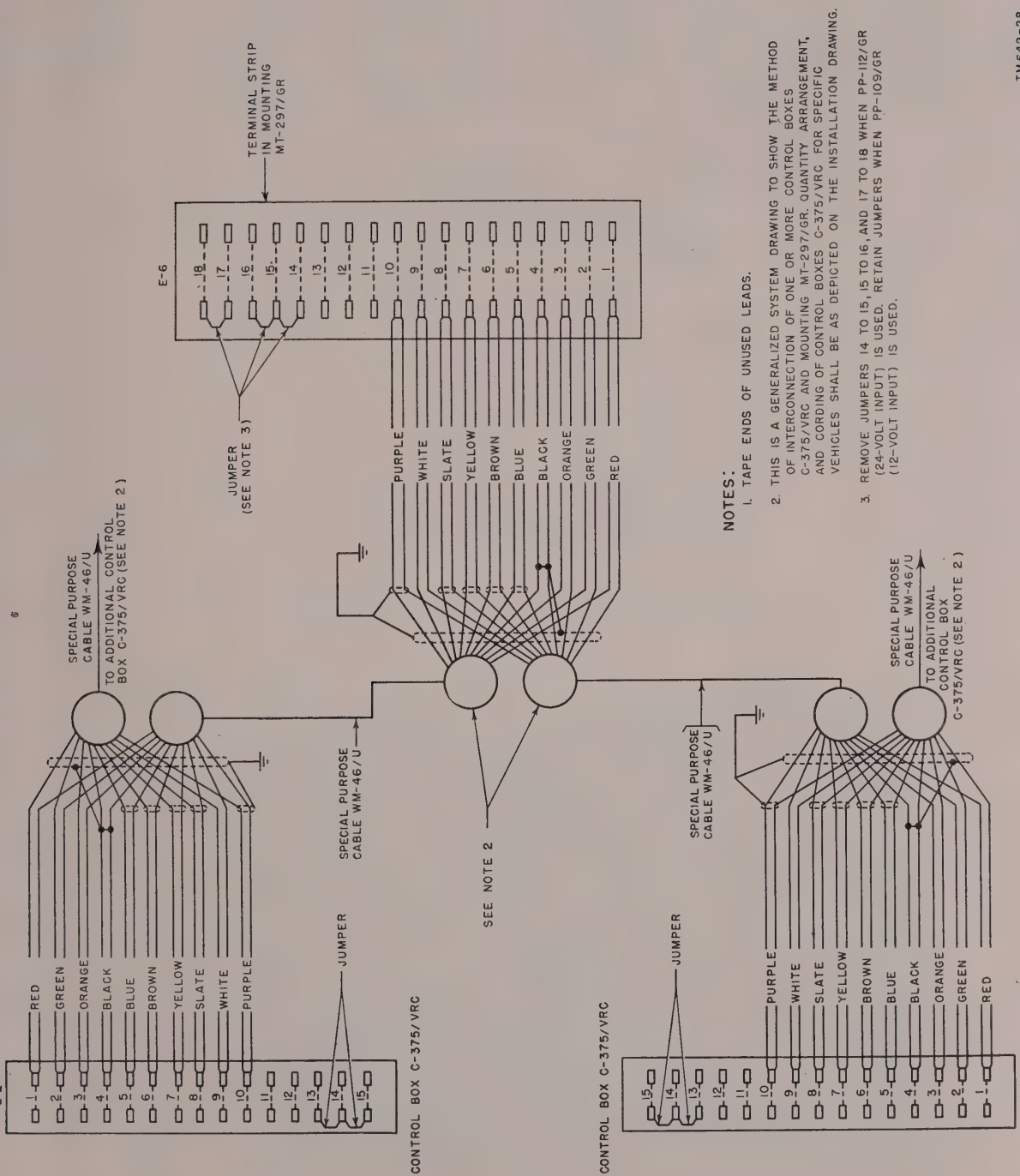
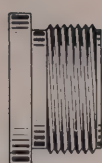


Figure 21. Interconnection of Mounting MT-297/GR and Control Box C-375/VRC.







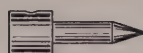
NUT



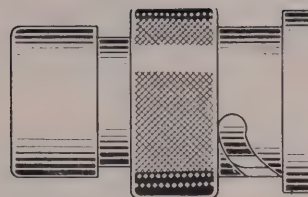
BRASS  
WASHER



PLASTIC  
BUSHING



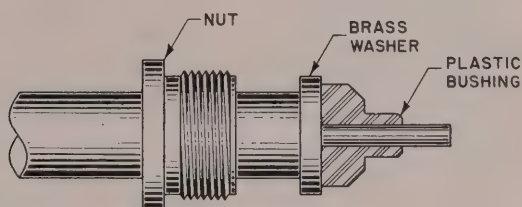
PIN



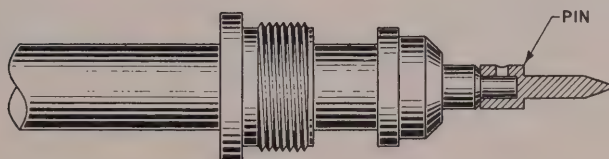
JACK BODY



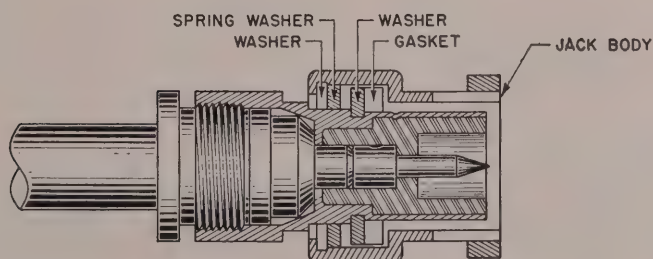
1. CUT OFF CABLE SHARP AND SKIN BACK INSULATION CLEANLY TO  $\frac{23}{64} + \frac{1}{64}$  OF AN INCH. TWIST THE WIRES AND DIP IN SOLDER.



2. SLIP NUT, BRASS WASHER, AND PLASTIC BUSHING ON CABLE AS SHOWN.



3. SLIP PIN ON WIRE AND PUSH BACK AS FAR AS POSSIBLE. HEAT PIN WITH SOLDERING IRON AND FLOW SOLDER INTO THE HOLE IN THE PIN TO MAKE A GOOD CONNECTION. TAKE CARE NOT TO OVERHEAT THE PLASTIC BUSHING.



4. PLACE JACK BODY ON CABLE AND RUN NUT UP TO SECURE A TIGHT FIT.

*Figure 24. Termination of RF Cable Assembly CG-568/U.*

TM 611-14

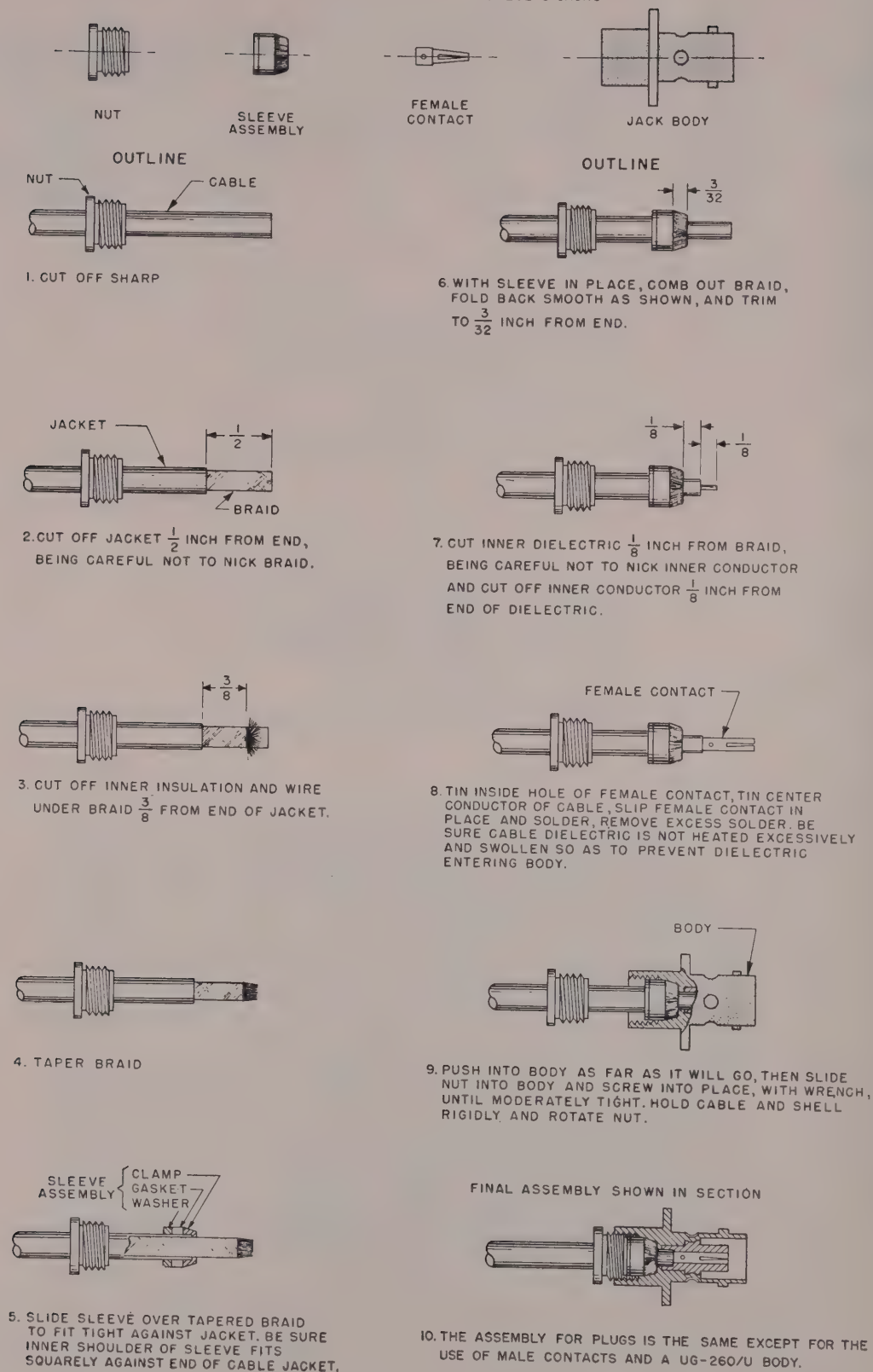


Figure 25. Termination of RF Cable Assembly CG-530/U.

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pletion in one or two steps, the antenna mast base is the next item to be installed (par. 29).

## 27. Storing Audio Accessories

The audio accessories supplied in the instal-

lation unit will not be required until the equipment is ready for an operational test (par. 38). The accessories should be unpacked and stored within the vehicle (after equipment installation) until they are needed.

## Section III. EQUIPMENT INSTALLATION DETAILS

*Note.* The term *equipment installation* refers to those installation procedures which are independent of the vehicle in which the radio sets are installed.

## 28. Unpacking

When all vehicular installation details have been completed, unpack the remaining boxes (1 and 2) of the basic unit (par. 8). Observe the general precautions noted in paragraph 21.

## 29. Mounting Mast Base AB-15/GR (fig. 26)

The location of the mast base is, in most cases, prescribed by the vehicle. In general, however, the mast base should be placed as high as possible and with a maximum cable length of 50 inches between the base and the receiver-transmitter. To install the mast base, follow the instructions outlined below and in figure 26.

a. Loosen the ground clamp on the adapter which is supplied on the mast base. Remove the adapter, and replace it with Adapter UG-

273/U. Retighten the ground clamp on the new adapter.

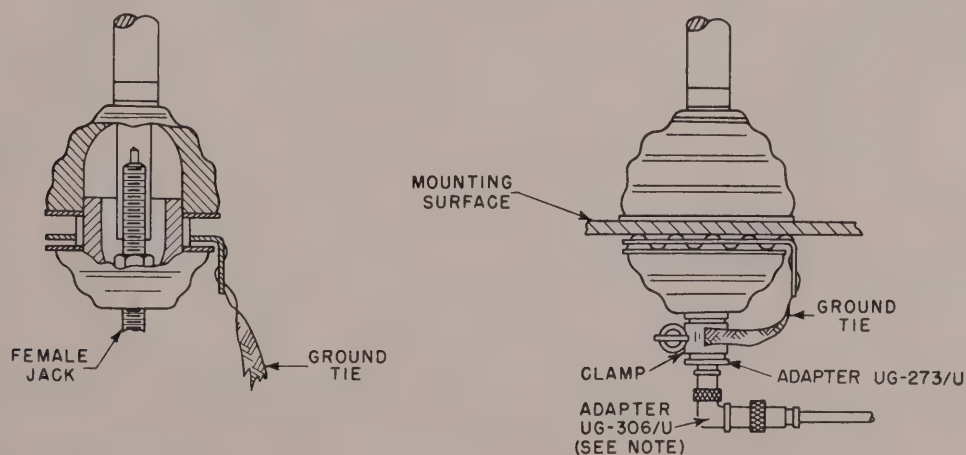
b. Separate the two cup insulators by unscrewing the body of the mast base.

c. Insert the body of the mast base, with upper cup insulator attached, through the hole in the mounting surface, which may be a special surface.

d. Bring the lower cup insulator up from the under side of the mounting surface so that the bolt in the lower insulator engages the body of the mast base. The lockwasher and the ground tie from the clamp on the adapter should be between the mounting surface and the lower insulator (fig. 26).

e. Screw the body of the mast base in a clockwise direction to tighten the assembly.

f. If the mounting surface does not provide a good ground, an additional ground bond must be made between the mounting surface and the vehicle.



NOTE:  
ADAPTER UG-306/U USED ONLY WHEN  
SPECIFICALLY CALLED FOR.

TM 287-52

Figure 26. Mast Base AB-15/GR, installation drawing.

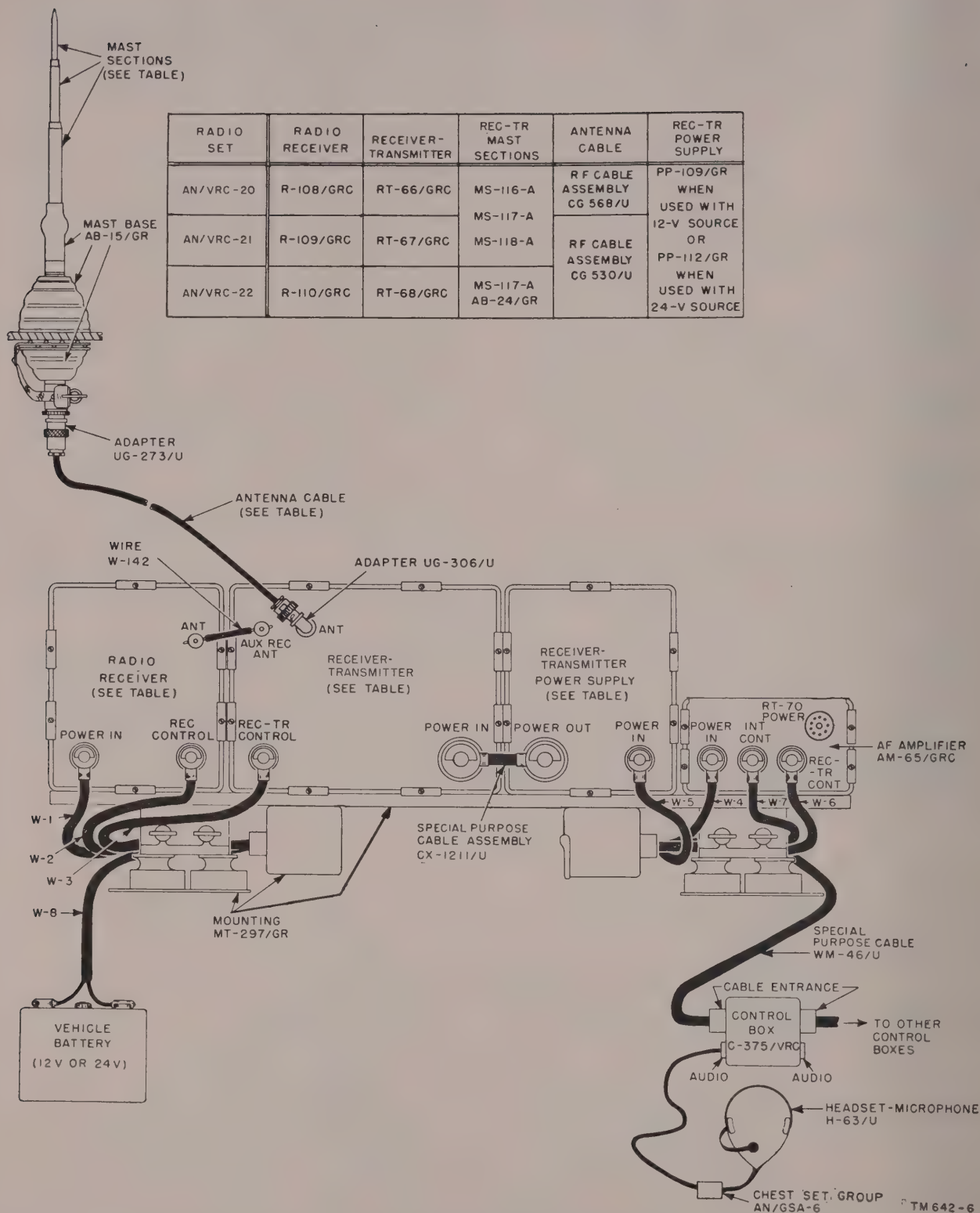


Figure 27. System cordage diagram.



### 30. Antenna Mast Sections (fig. 27)

a. Radio Sets AN/VRC-20 and -21 utilize three long mast sections; Mast Sections MS-116-A, MS-117-A, and MS-118-A. Screw the three sections together, then turn the assembly into the mast base.

b. Radio Set AN/VRC-22 utilizes one long and one short mast section; Mast Sections MS-117-A and AB-24/GR. Screw the two sections together, then turn the assembly into the mast base.

### 31. AF Amplifier AM-65/GRC

A power supply must be installed in the amplifier, and the fuse and internal power supply switch must be checked before the amplifier is secured on the mounting. Proceed as follows:

a. Remove the panel-chassis assembly from the outer case (par. 106).

b. Insert and clamp the plug-in power supply unit (fig. 7) in the compartment on the amplifier chassis (fig. 46) so that the receptacle on the power supply mates with the plug within the amplifier compartment. Use Power Supply PP-281/GRC for 12-volt systems and use Power Supply PP-282/GRC for 24-volt systems.

c. Turn the internal switch (S-1) on the amplifier chassis (fig. 46) to the 12V or 24V position, depending on the supply voltage being used.

d. Check the fuse in the fuseholder on the front panel of the amplifier. The amplifier is shipped with a 4-ampere fuse which is suitable for operation in a 24-volt system with Power Supply PP-282/GRC. For 12-volt systems, which use Power Supply PP-281/GRC, replace the 4-ampere fuse with a 10-ampere fuse from the running spares supplied with the unit (par. 19). Place a spare fuse of the proper amperage for the system in the clips on the chassis (fig. 46).

e. Fasten the correct supply voltage marker on the left-hand side of the amplifier panel. The amplifier is shipped with the 24V 4A marker in place (fig. 8). For 12-volt systems, the marker should be replaced by the 12V 10A marker which is located beneath the 24V 4A marker. The marker serves as a reminder that the plug-

in power supply unit, the fuse, and the setting of the internal switch (c and d above) should correspond to the storage battery being used.

f. Replace the panel-chassis assembly in the case and turn the OFF-INT-RT-70 switch to the OFF position.

**Caution:** Before placing the amplifier or any of the units on the mounting, again check the position of the power switch on the mounting. Make sure that it is in the OFF position.

g. Release the locking mechanism for the two right-hand channels of the mounting by rotating the locking handles (fig. 9) toward the left.

h. Place the amplifier on the mounting so that the rails on the bottom of the case rest in the two right-hand channels of the mounting. Rotate the locking handles to the right to secure the amplifier in place.

### 32. Receiver-Transmitter and Receiver-Transmitter Power Supply

a. Place the OPERATE switch of the receiver-transmitter Power Supply PP-109/GR or PP-112/GR in the OFF position, and secure the unit on the mounting beside AF Amplifier AM-65/GRC (fig. 27). Use Power Supply PP-109/GR in 12-volt systems and Power Supply PP-112/GR in 24-volt systems.

b. Place and lock the receiver-transmitter on the mounting next to the power supply. Refer to the table in figure 27 for the particular receiver-transmitter used in each system.

### 33. Auxiliary Receiver

A power supply must be installed in the auxiliary receiver, and the internal power supply switch must be checked before the unit is secured on the mounting. Proceed as follows:

a. Remove the panel-chassis assembly from the outer case (par. 106).

b. Insert and clamp the plug-in power supply unit (fig. 7) in the compartment on the receiver chassis (fig. 55) so that the receptacle on the power supply mates with the plug within the receiver compartment. Use Power Supply PP-281/GRC for 12-volt systems and use Power Supply PP-282/GRC for 24-volt systems.

c. Turn the internal switch (S-1) on the right-hand side of the receiver chassis to the 6, 12, & 24 VOLTS position (fig. 56).

d. The receiver is shipped with the 24V 4A marker in place. For 12-volt systems, the marker should be reversed so that the face marked 12V 4A is exposed (fig. 6). To reverse the marker, remove the fuse cap and knurled nut which secure the marker plate. Then reverse the marker plate so that the face with 12V 4A is exposed. Secure the plate by replacing and tightening the knurled nut and the fuse cap. The marker serves as a reminder to use the proper plug-in power supply unit (PP-281/GRC or PP-282/GRC) with the vehicular storage battery being used.

e. Replace the panel-chassis assembly in the case and place the combined power and VOLUME control of the receiver in the OFF position (extreme counterclockwise).

f. Place and lock the auxiliary receiver on the mounting beside the receiver-transmitter (fig. 27).

### 34. Interconnections

Make the system interconnections outlined below and illustrated in figure 27.

a. Connect Adapter UG-306/U to the ANT connector on the receiver-transmitter. Connect one end of the antenna cable (RF Cable Assembly CG-568/U or CG-530/U as indicated in fig. 27) to the adapter; connect the other end of the cable to the receiver-transmitter mast base (par. 29).

b. Connect Wire W-142 between the AUX-REC ANT connector on the receiver-transmitter and the lower ANT connector on the panel of the auxiliary receiver.

c. Check that the power switch on the mounting and the OFF-INT-RT-70 switch on the interphone amplifier are in the OFF positions.

d. Check that the OPERATE switch of the receiver-transmitter power supply is in the OFF position, and connect Special Purpose Cable Assembly CX-1211/U between the POWER OUT receptacle of the power supply and the POWER IN receptacle of the receiver-transmitter. Tighten the screw handles on the cable assembly connectors to insure waterproofing.

*Note.* Before performing the operations in e through j below, check that the cables are laid out as shown in figure 19. When making the cable connections, use figure 27 as a guide. Make sure that the cables do not rest on any part of the mounting below the shock mounts.

e. Connect cable W-6 from the mounting (fig. 19) to the REC-TR CONT receptacle on the amplifier. Tighten the screw-handle on the cable connector.

f. Connect cable W-7 from the mounting to the INT CONT receptacle on the amplifier. Tighten the screw handle on the cable connector.

g. Connect cable W-4 from the mounting to the POWER IN receptacle on the amplifier. Tighten the screw handle on the cable connector.

h. Connect cable W-5 from the mounting to the POWER IN receptacle on the receiver-transmitter power supply. Tighten the screw handle on the cable connector.

i. Connect cable W-3 from the mounting to the REC-TR CONTROL receptacle on the receiver-transmitter. Tighten the screw handle on the cable connector.

j. Connect cables W-1 and W-2 from the mounting to the POWER IN and REC CONTROL receptacles, respectively, on the auxiliary receiver. Tighten the screw handles on the cable connectors.

### 35. Audio Accessories

a. *Assembly.* The chest sets, headsets, and headset-microphone sets provided in the installation unit should be assembled and made ready for use. The remaining audio accessories are shipped assembled.

b. *Disposition.* The specific disposition and usage of audio accessories depend, in part, on vehicular conditions and modes of operation to be used. Probable dispositions are indicated below. Any one of the audio accessories described below may be connected to any unit in the radio set which has a matching audio connector. (See ch. 3 for the operating modes possible at the various audio connectors.)

- (1) Chest Set Group AN/GSA-6 is used with Headset-Microphone H-63/U at one of the audio connectors of Control Box C-375/VRC.
- (2) Dynamic Loudspeaker LS-166/U, when supplied, can be used at an audio connector of the auxiliary receiver, the receiver-transmitter, or the interphone amplifier.
- (3) Microphone M-29/U can be used at an audio connector of the receiver-



transmitter or the interphone amplifier when some general means of monitoring (for example, a loudspeaker) is provided.

- (4) Headset Navy Type CW-49507 with Cord CX-1334/U can be used at an audio connector of the receiver-trans-

mitter or the auxiliary receiver for individual set monitoring.

- (5) Handset H-33/PT generally is used at either Remote Control C-433/GRC or Local Control C-434/GRC when these auxiliary units are used.

## Section IV. ADJUSTMENTS FOR OPERATION

*Note.* Personnel performing the procedures described in this section should be familiar with the use of the controls and with the operating procedures described in chapter 3.

### 36. Receiver-Transmitter Antenna Tuning

The receiver-transmitter is shipped completely aligned but the receiving and transmitting antenna circuits must be tuned when the set is connected to its particular antenna system. Once the antenna circuits are tuned for a particular system antenna, it is not necessary to retune during normal operation.

*Note.* Keep all personnel removed as far as possible from the antenna while making the following adjustments.

*a. Receiver Tuning.* Perform steps 1 through 10, and 14 through 25 of the equipment performance checklist (par. 94) to determine that the receiver is operating. Leave the receiver operating with the SQUELCH control at OFF, and adjust as follows:

- (1) Tune for a signal in the top 900 kc of the tuning range (par. 55). Tune the auxiliary receiver (*even though power may be off*) to a frequency at least 4 mc below that of the receiver-transmitter. If practicable, arrange to have this signal supplied by another radio set. If another set is not available, radiate the output of an f-m signal generator to the receiver. Do not allow this signal to be any stronger than is necessary for comfortable reception. Otherwise the sharpness of the tuning will be decreased.
- (2) Using a screw driver, adjust the REC ANT TUNE control on the receiver-transmitter panel for maximum noise quieting and maximum signal strength in the headset. Reduce the r-f input signal strength as the strength of the a-f signal increases. Repeat the adjustment.

*b. Transmitter Tuning.* Perform steps 1 through 10, and 14 through 32 of the equipment performance checklist (par. 94) to determine that the transmitter is operating. To tune the transmitter antenna circuit, proceed as follows:

- (1) Tune the receiver-transmitter (par. 53) to the extreme low end of its tuning range (MCS tuning control at lowest mc calibration; TENTH MCS tuning control at zero). Leave the TENTH MCS tuning control at zero throughout the tuning procedure.

**Caution:** Do not turn the TENTH MCS tuning control while the TR ANT TUNE control is being adjusted. Serious damage to the tuning mechanism can result.

- (2) Turn the TRANS ANT COUPLING control on the receiver-transmitter panel completely counterclockwise to obtain minimum coupling.
- (3) Press and hold the RADIO-INT and press-to-talk switches on the chest set.

**Caution:** Do not operate the transmitter for more than 5 minutes continuously. Allow a 15-minute stand-by period between each 5-minute period of continuous operation. This prevents overheating and possible damage to the receiver-transmitter power supply as well as excessive battery drain.

- (4) Remove the cap which covers the TR ANT TUNE control on the receiver-transmitter panel. Engage the control by pressing in on it with a screw driver, and adjust for a maximum r-f

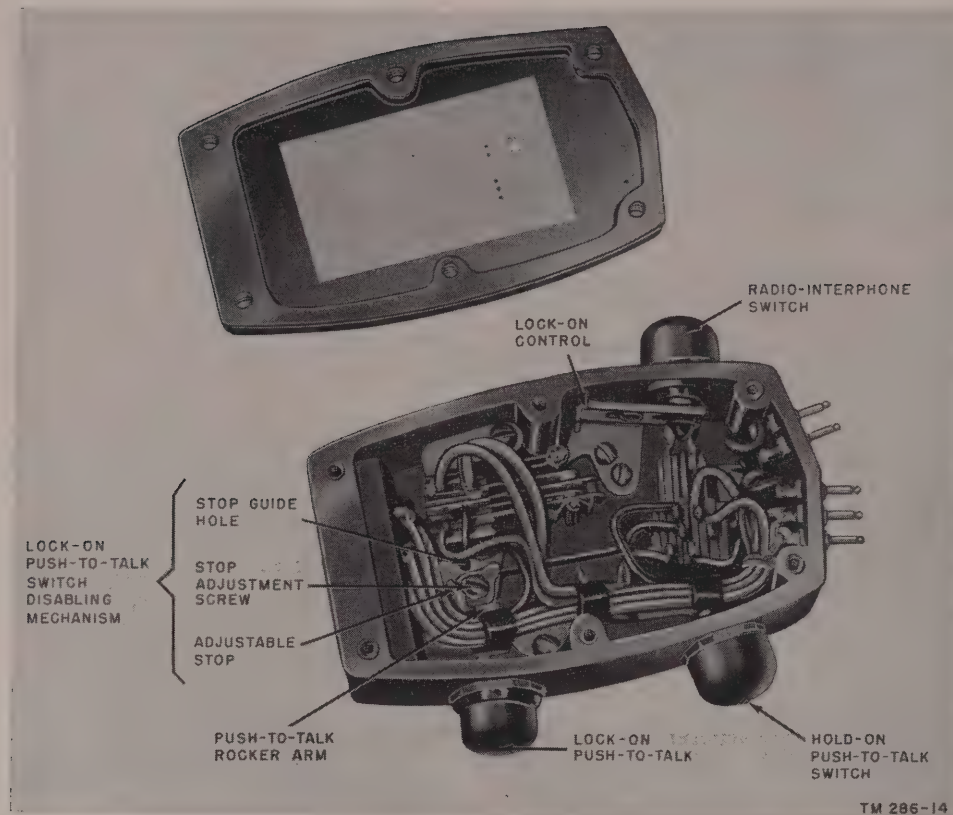


Figure 28. Chest Set Group AN/GSA-6, internal view.

reading on the panel meter. If it is impossible to obtain a reading, advance the setting of the TRANS ANT COUPLING control slightly and repeat the procedure. Keep the coupling as low as possible while adjusting the TR ANT TUNE control for a maximum r-f reading. When the maximum reading is obtained, release the RADIO-INT or push-to-talk switch on the chest set.

- (5) Repeat the adjustments given in (3) and (4) above for each integral mc calibration on the MCS dial and for the highest detented frequency of each receiver-transmitter (27.9, 38.9, and 54.9 mc for Receiver-Transmitters RT-66/GRC, RT-67/GRC, and RT-68/GRC, respectively).
- (6) When adjustments are complete for each setting of the MCS tuning control, turn the MCS tuning control to the approximate center of the tuning range, and adjust the TRANS ANT

COUPLING control for a maximum r-f reading.

- (7) Repeat the adjustments given in (3) through (6) above. *However, do not disturb the setting of the TRANS ANT COUPLING control.*

### 37. Auxiliary Receiver Tuning

The antenna circuits of the auxiliary receiver must be tuned for the particular antenna system with which the receiver is used. The tuning procedure is outlined in a(1) through (3) below.

a. Perform steps 1 through 4, 11 through 19, and 33 through 41 of the equipment performance checklist (par. 94). Leave the receiver operating and adjust as follows:

- (1) Tune the receiver at the highest calibrated frequency of its range (par. 56a, (1) through (5)). Tune the receiver-transmitter at least 4 mc below the auxiliary receiver during this operation.



- (2) With the TUNE-DIAL LIGHT (ON-OFF) switch held in the TUNE position, tune off the calibrate frequency until the beat note can no longer be heard but so that the quieting effect of the tuning signal is still apparent.
- (3) With the TUNE-DIAL LIGHT (ON-OFF) switch still in the TUNE position, use an ordinary screw driver to adjust the ANT TUNE control for maximum quieting in the headset.

b. The following procedure minimizes interference between the receiver-transmitter and the auxiliary receiver to enable these units to be operated at frequencies as close as 1 mc from each other. This interference is noticeable only in Radio Set AN/VRC-22 when weak signals are being received. If the two units are adjusted to produce maximum interference (weakening of signal) when they are tuned to the same frequency, the interference will be reduced sufficiently at frequencies 1 or more mc apart to allow satisfactory operation. Proceed as follows:

- (1) Set both receivers (the receiver sec-

tion of the receiver-transmitter and the auxiliary receiver) at the same frequency in the top 900 kc of the tuning range by tuning each to the same weak signal.

- (2) Adjust the REC ANT TUNE control on the receiver-transmitter to that point where the signal received in a headset connected to the output of the auxiliary receiver is weakest. This adjustment will be close to the setting obtained in paragraph 36 (approximately one-half turn).

### 38. Operational Check

When the receiver-transmitter and the auxiliary receiver have been tuned, make a complete operational check of the system by performing the procedure outlined in the equipment performance checklist (par. 94). If abnormal indications are obtained, it will be necessary to trouble shoot the system. When required, follow the trouble-shooting suggestions contained in the checklist.

## CHAPTER 3

### OPERATING INSTRUCTIONS

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#### Section I. MODES OF OPERATION

##### 39. Monitoring

Listening to received signals with no attempt to communicate with the sending station constitutes monitoring. The receiver section of the receiver-transmitter in the radio set can be operated strictly as a monitor if desired. The receiver can be monitored at the interphone box, the local or remote control units when used, the interphone amplifier, and the unit audio connector.

##### 40. Push-to-talk Operation

a. Push-to-talk operation requires closure of one or more switches (generally the push-to-talk switch of a chest set, handset, or microphone). Communication is possible only in one direction at a time and it is impossible for the receiving party to *break-in* on the sending party.

b. Push-to-talk operation of the receiver-transmitter usually is selected at the interphone box (par. 61). A chest set at the interphone box is most commonly used. It is also possible to operate the receiver-transmitter individually by means of a chest set or handset connected directly to the unit audio connector.

##### 41. Interphone Facilities

Interphone facilities are available to the operators at each interphone box and at the panel of the interphone amplifier. Normally, the panel of the interphone amplifier will not be used as an interphone station, but it is a convenient point for checking the operation of the amplifier (par. 96).

##### 42. Remote Control Facilities

The use of Control Group AN/GRA-6 (auxiliary equipment) makes it possible to control application of power to the radio sets and/or push-to-talk operation of the receiver-transmitter from a control station 2 miles from the major installation. See paragraphs 132 through 137 for operating details.

##### 43. Duplex Telephone Facilities

When Control Group AN/GRA-6 (auxiliary equipment) is used for remote control of the radio sets, duplex telephone facilities are available for communication between local and remote control units whether or not the local control unit is plugged into the mounting (par. 135). Duplex telephone operation allows for simultaneous two-way talking and listening.

#### Section II. CONTROLS

##### 44. Introduction

This section describes the functions of operational controls on the panels of the various units. Although ordinary operating procedures are confined mainly to control units and audio accessories, an understanding of the controls on the individual units is essential for efficient operation and maintenance of the radio sets.

*Note.* Controls on Local Control C-434/GRC and

Remote Control C-433/GRC (auxiliary equipments) are described in paragraphs 129 and 130.

##### 45. Mounting

The main switch for the radio sets and a clear pilot lamp are mounted on the junction boxes of Mounting MT-297/GR (fig. 9). The functions of the switch and lamp are indicated in the following chart:



Control or instrument	Function	Control	Function
OFF-REMOTE-ON switch (S-1)	Controls battery power to the radio sets. OFF: Opens battery circuit in the mounting. REMOTE: Allows power to be controlled at Remote Control C-433/GRC. ON: Connects battery power to the input terminals of the interphone amplifier, the receiver-transmitter power supply, and the auxiliary receiver.	OFF-INT-RT-70 switch	Controls power for the interphone amplifier and for a second receiver-transmitter (if it is used). OFF: Breaks battery circuit at input terminals of the amplifier. INT: Completes power circuits for interphone amplifier. RT-70: Completes power circuits for interphone amplifier and Set 2 receiver-transmitter (not used).*
POWER lamp (E-7)	Indicates (when lit) that power has been made available at the input terminals of the interphone amplifier, the receiver-transmitter power supply, and the auxiliary receiver. Dimmer control provides for masking the glow of the lamp.	VOLUME control (R-26)	Controls output level from Set 1 + Set 2 + Interphone channel to panel-mounted AUDIO connector.
		AUDIO connector (J-1)	Provides means for connecting a chest set (with microphone-headset) for monitoring and interphone operation over the Set 1 + Set 2 + Interphone channel.

### 46. Interphone Amplifier

The controls of the interphone amplifier are shown in figure 29 and their functions are listed in the following chart:

\* Do not turn the OFF-INT-RT-70 switch to the RT-70 position unless a Receiver-Transmitter RT-70/GRC, or its equivalent load is used.

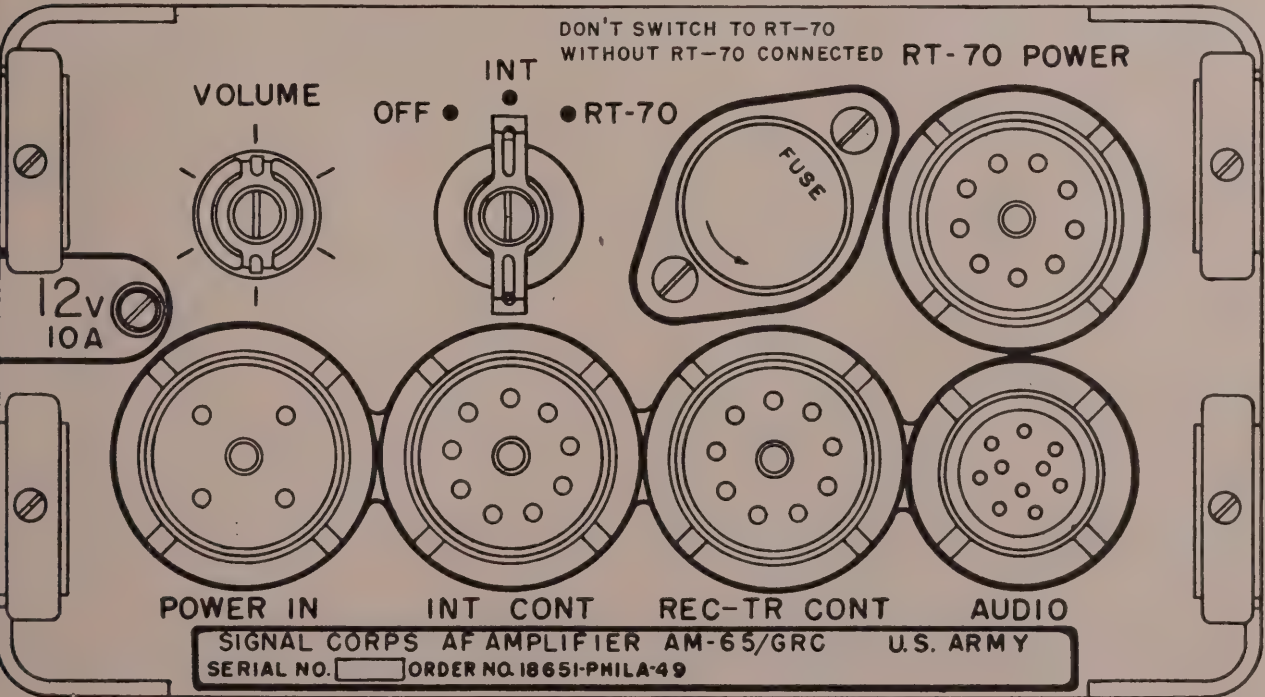


Figure 29. Interphone amplifier control panel.

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## 47. Receiver-Transmitter Power Supply

The controls for both the 12- and 24-volt power supplies (Power Supplies PP-109/GR and PP-112/GR, respectively) are the same. Figure 30 illustrates the panel layout of the controls. The control functions are listed in the following chart:

Control	Function
OPERATE switch (S-1).	Controls power to the receiver-transmitter power supply. OFF: Opens battery circuit at input terminals of the power supply. RECEIVE: Completes battery circuit to receiver power supply circuits and to receiver-transmitter relay supply circuit.* TRANS & RECEIVE: Completes battery circuit to transmitter power supply circuits in addition to those circuits listed under the RECEIVE position.
TRANS POWER switch (S-2).	Provides for HIGH or LOW r-f power operation of the transmitter in the HIGH and LOW positions respectively.

\* In some of the later power supplies, the receiver-transmitter relay supply circuit is completed only when the OPERATE switch is in the TRANS & RECEIVE position. Consult circuit label on receiver-transmitter power supply. Also see figures 88 and 89.

## 48. Receiver-Transmitter

The controls for the receiver-transmitter (Receiver-Transmitter RT-66/67/GRC, or RT-68/GRC) are illustrated in figure 31. The control functions are listed in the following chart:

Control or instrument	Function
Dial LAMP (E-313) ..	Illuminates tuning dials except when DIAL LIGHT (OFF-ON)-RING switch is at OFF.
DIAL LIGHT (OFF-ON)-RING switch (S-302)	Controls dial LAMP, microphone, and ringing oscillator circuits. Spring-loaded to return to DIAL LIGHT ON position from RING position. OFF: Completes microphone circuit and turns dial LAMP off.

Control or instrument	Function
	ON: Completes microphone circuit and turns dial LAMP on. RING: Breaks microphone circuit, turns on ringing oscillator, energizes the transmitter, and turns on dial LAMP.
VOLUME control (R-303).	Adjusts the audio output level to speaker and phones terminals of the panel-mounted AUDIO connectors.
SQUELCH control (R-302 and R-303).	Controls the noise suppression circuits of the receiver, and determines what minimum level of input signal will be required for operation of the receiver. In OFF position, provides no noise suppression and allows receiver to operate at maximum sensitivity.
MCS and TENTH MCS tuning controls and dials.	Select and indicate the operating frequency. MCS: Selects and indicates each integral mc of the tuning range in 1-mc steps. TENTH MCS: Selects and indicates the decimal portion of the operating frequency in either 100-kc steps or in a continuous sequence.
Preset levers .....	Provide means of presetting one or two detented channels (par. 54).
Meter (M-301) .....	Indicates transmitter r-f power output, filament continuity, and availability of d-c (85-volt) operating potential.
METER selector switch (S-301).	Connects meter to test points as indicated below. RF position: Connects meter to transmitter r-f output circuit. Positions 2 through 11: Connect meter to various filament circuits (fig. 83). 90V position: Connects meter to 85-volt d-c supply circuit.
TR ANT TUNE control (C-74).	Adjusts transmitter antenna circuit tuning. (This is not an operational adjustment).
TRANS ANT COUPLING control	Adjusts coupling between transmitter output stage



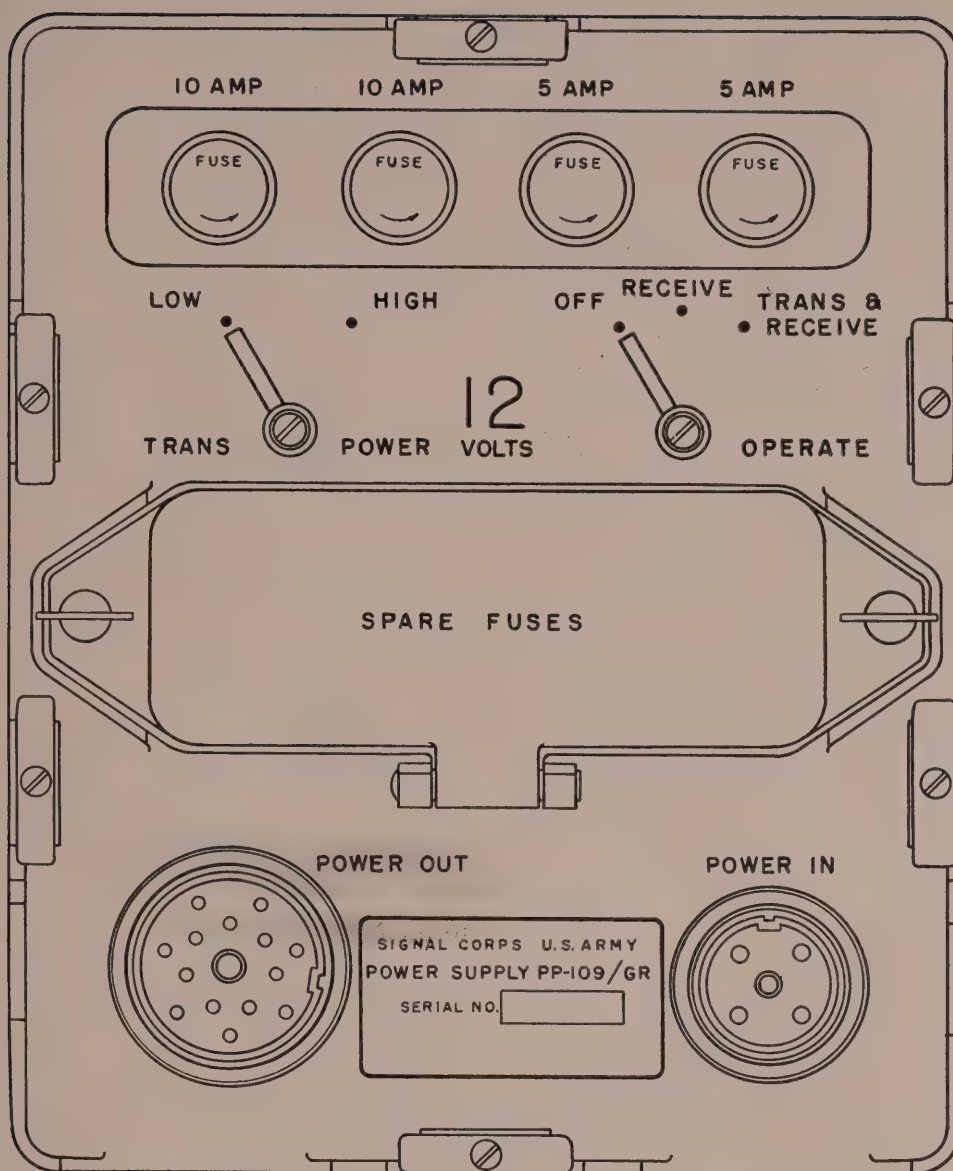


Figure 30. Receiver-transmitter power supply panel. TM5036-7

Control or instrument	Function
(L-23).	and the antenna. (This is not an operational adjustment).
REC ANT TUNE control (C-1A).	Adjusts receiver-antenna circuit tuning. (This is not an operational adjustment).
AUDIO connectors (J-310 and J-311).	Provide means of connecting chest set (with headset-microphone), microphone, headset, handset, or speaker for monitoring or push-to-talk operation of the receiver-transmitter.

#### 49. Auxiliary Receiver

The controls and instruments of all the auxiliary receivers (Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC) are the same. The location of controls is illustrated in figure 32; their functions are listed in the following chart:

Control or instrument	Function
Power switch and VOLUME control (S-2 and R-62).	Controls power to the receiver and audio output level to speaker and phones terminals. Battery circuit is broken at the input

Control or instrument	Function	Control	Function
Dial LAMP (E-14)	terminals of the unit when control is at OFF position. Illuminates channel dial except when TUNE DIAL LIGHT OFF-ON switch is in OFF position.	DETENT VERNIERS.	Provide a fine adjustment on the setting of the detents.
TUNING control	Selects the operating frequency.	TUNE-DIAL LIGHT	Controls operation of the tuning oscillator and dial light.
CHANNEL dial	Indicates the operating frequency selected by the TUNING control. Major calibrations are in mc and minor calibrations are indicated at 100-kc (.1-mc) intervals.	(ON-OFF) switch (S-3).	TUNE: Spring return position which turns on oscillator and couples oscillator output to r-f amplifier; turns on dial LAMP.
Detent adjustments	Provide means of presetting any three frequencies within the range of the receiver. (Located beneath diamond-shaped plate near center of the panel).	SQUELCH control (R-65 and S-4).	DIAL LIGHT ON: Turns on dial LAMP. DIAL LIGHT OFF: Turns off dial LAMP. Controls noise suppression and determines what minimum level of input signal will be required for receiver operation. In OFF position, provides for no noise suppression and al-

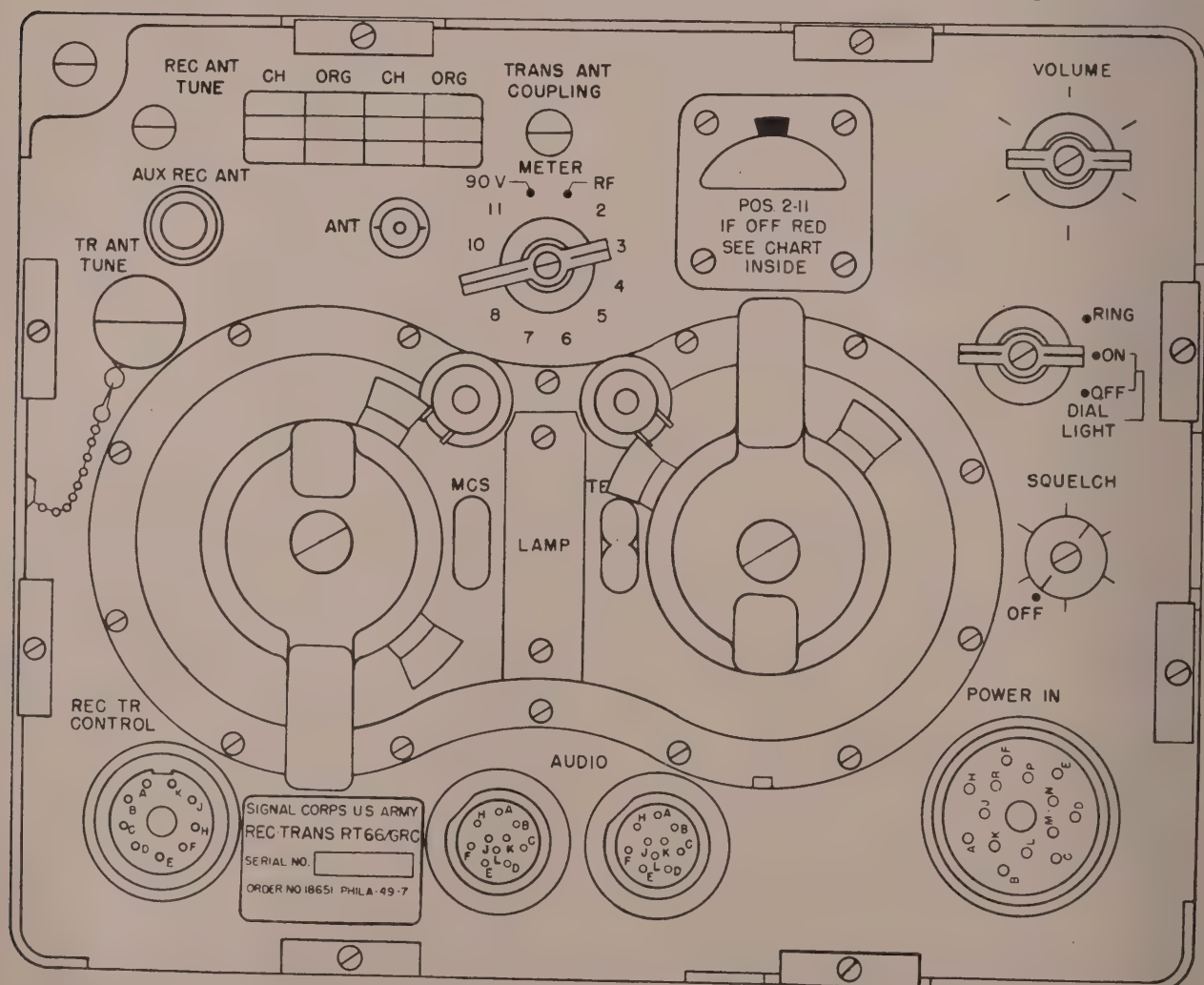


Figure 31. Receiver-transmitter control panel.

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Control or instrument	Function
ANT TUNE control (C-4).	allows receiver to operate at maximum sensitivity.
AUDIO connector (J-7).	Provides means of tuning antenna circuit.
	Provides means for connecting a headset or speaker for separate local monitoring of the receiver.

### 50. Control Box C-375/VRC

The controls on Control Box C-375/VRC are illustrated in figure 33. Functions of the controls are listed in the following chart:

Control	Function
Selector switch (S-1) ..	<p>Completes monitoring circuits to PHONE jacks and audio receptacles. In conjunction with RADIO TRANS. switch, completes push-to-talk circuits to the MIC. jacks and audio receptacles.</p> <p>Counterclockwise position (Set 1 + AUX REC + INT): Completes monitoring circuit of both receivers and interphone regardless of position of RADIO TRANS. switch; completes push-to-talk circuit of the receiver-transmitter to PHONE jacks and audio receptacles when RADIO TRANS. switch is operated.</p> <p>Center position (SET 1 + AUX REC + INT): Completes monitoring circuit of both receivers and interphone; completes interphone push-to-talk circuit to MIC jacks and audio receptacles when RADIO TRANS. switch is at RADIO TRANS.</p> <p>Clockwise position (INT): Completes only the interphone monitoring circuit to the PHONE jacks and audio receptacles.</p> <p>Controls push-to-talk operation. Spring-loaded to return to the center position if not held in either of the RADIO TRANS. positions. A locking device is provided to hold the switch</p>
RADIO TRANS. switch (S-2).	

Control	Function
	<p>in one of the RADIO TRANS. positions.</p> <p><i>Note.</i> When Chest Set AN/GSA-6 is used, the RADIO TRANS. switch should be locked in either one of its RADIO TRANS. positions. The functions of the RADIO TRANS. switch are then performed by the RADIO-INT button on the chest set. When the RADIO-INT button is at INT (unoperated), pressing the push-to-talk button completes the interphone push-to-talk circuit. When the RADIO-INT button is at RADIO (depressed) and the Selector switch is at Set 1, pressing the push-to-talk button completes the receiver-transmitter push-to-talk circuit.</p> <p>Clockwise and counterclockwise positions: Complete push-to-talk circuits to the MIC. jacks and audio receptacles when the selector switch is in the counterclockwise position.</p> <p>Center position: Opens receiver-transmitter push-to-talk circuit; closes interphone push-to-talk circuit.</p> <p>Vary the level of signals applied to their associated PHONE. jacks or audio connectors. Volume is increased by turning the control in the direction of the arrow.</p> <p>Provide for connection of Chest Set Group AN/GSA-6 (with Headset-Microphone H-63/U) for operation of the receiver-transmitter.</p> <p>Provide for connection of Microphone T-17 for operation of receiver-transmitter. (Efficiency of operation will be decreased by such usage and is not normally advisable if the standard audio accessories are available.)</p> <p>Provide for connection of Headset H-16/U or Headset HS-30 in combination with Cord CD-933 for monitoring the receiver-transmitter. (Efficiency of operation will be decreased by such usage and is not normally advisable if the standard audio accessories are available.)</p>
VOL. controls (R-1 and R-2).	
Audio connectors (J-1 and J-2).	
MIC. jacks (J-3 and J-4).	
PHONE jacks (J-5 and J-6).	



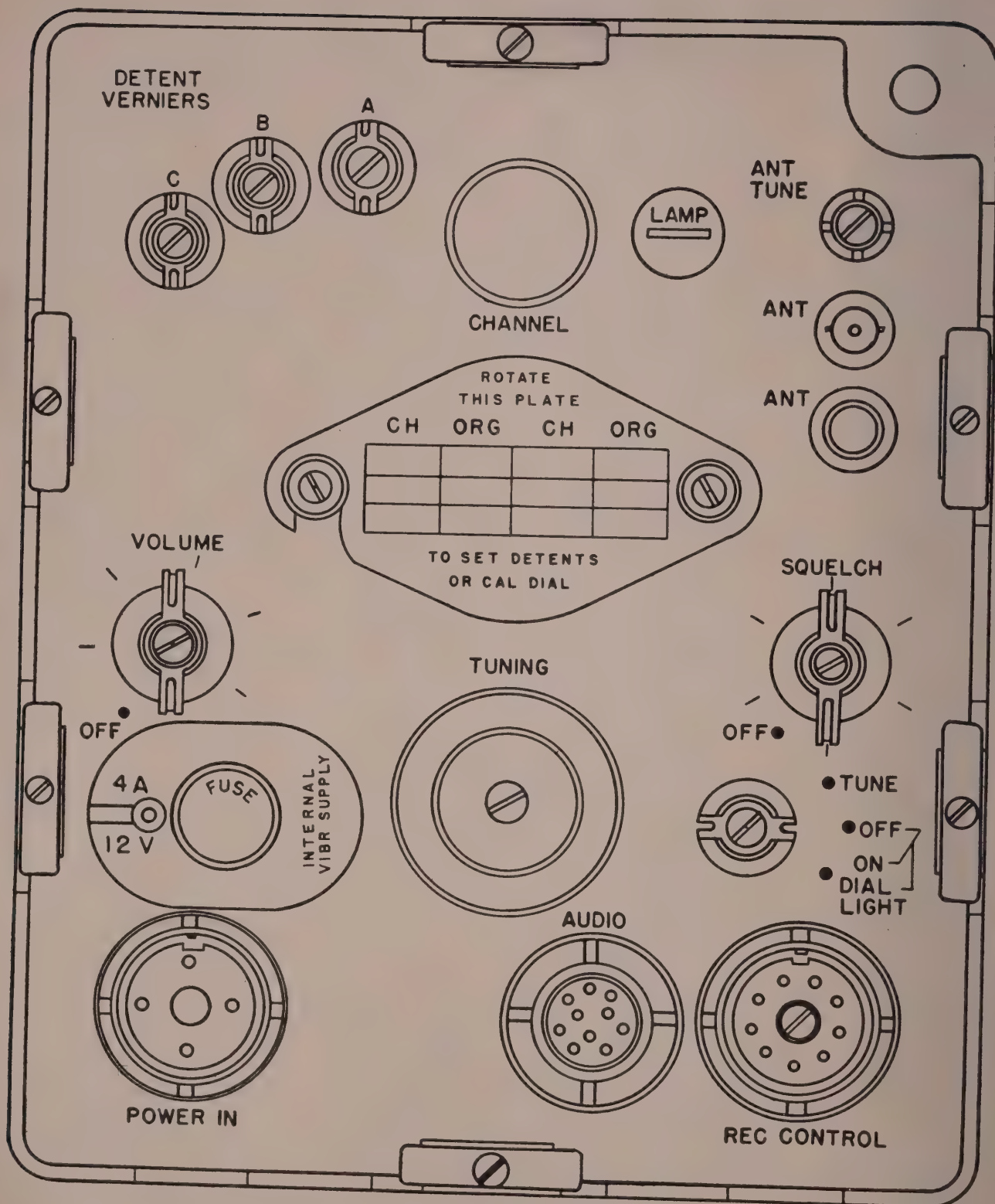


Figure 32. Auxiliary receiver control panel.

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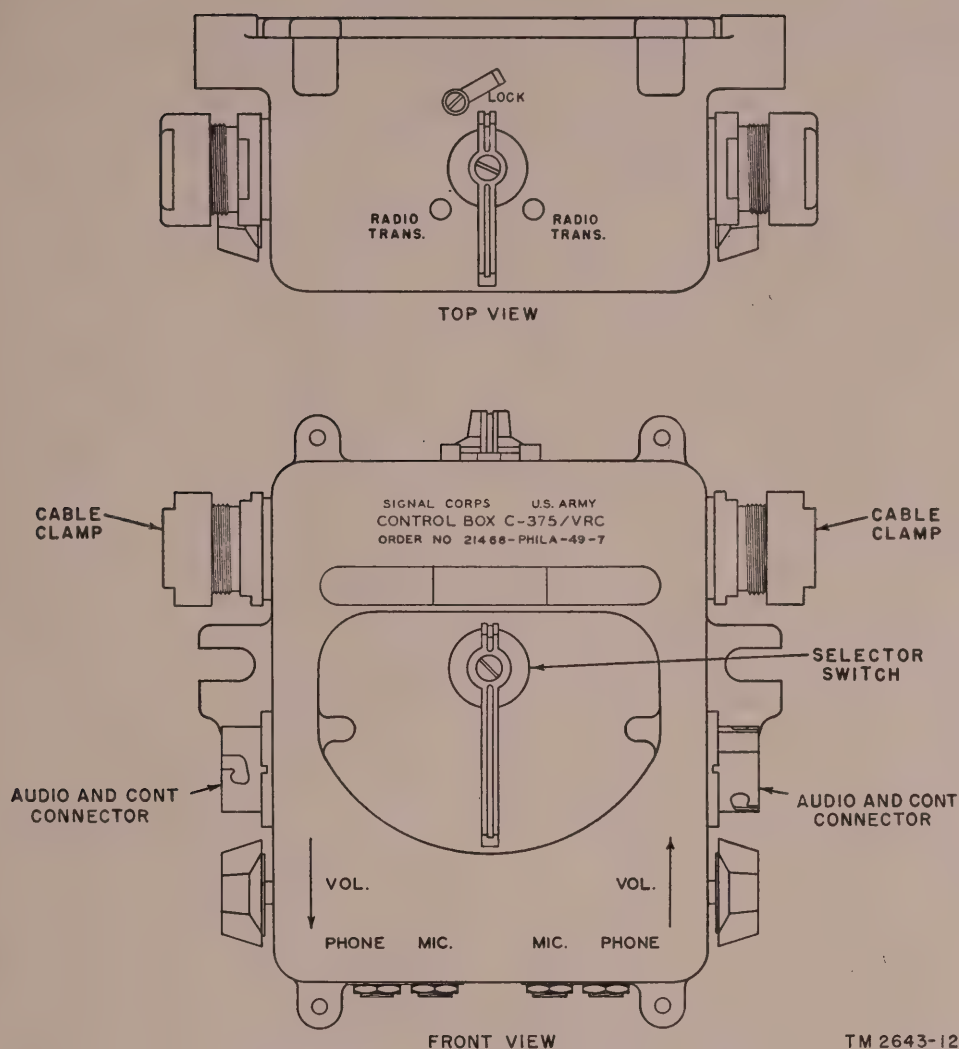


Figure 33. Control Box C-375/VRC, panel view.

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### Section III. TUNING

#### 51. Interference

The tuning of the receiver-transmitter and the auxiliary receiver involves not only the simple mechanics of control settings (pars. 53 through 56), but also a problem of frequency selection. Frequency selection must be made to avoid interference between the receiver-transmitter and the auxiliary receiver. Interference is minimized by the procedure described in paragraph 37b.

#### 52. Tuning Receiver-Transmitter

Once the antenna circuits have been tuned properly (par. 36), the receiver-transmitter can be tuned to any desired channel frequency

by merely turning the MCS and TENTH MCS controls to the proper detent positions (par. 53). Continuous tuning between channels is made possible by following the procedure outlined in paragraph 55. Any two detented channels may be preset for rapid selection by following the procedure outlined in paragraph 54.

#### 53. Channel Selection of Receiver-Transmitter

Channel selection is possible at every 100-kc interval between the lower and upper ends of the tuning range.

a. Turn the MCS control until the MCS dial indicates the integral portion of the desired frequency (for example, until the dial indicates 24 when the desired frequency is 24.8 mc).

b. Engage the detent for the TENTH MCS control by tuning the control to the extreme counterclockwise position. (If the detent is already engaged, omit this step.)

c. Turn the TENTH MCS control until the TENTH MCS dial indicates the decimal portion of the desired frequency; for example, until the dial indicates 8 when the desired frequency is 24.8.

*Note.* Do not hold the MCS control while turning the TENTH MCS control.

#### 54. Presetting Detented Channels of Receiver-Transmitter

Presetting is obtained by means of stops which limit the rotation of the tuning knobs. The stops can be swung into place for presetting (or removed when the presetting feature is not desired) by means of adjusting knobs. When in place for presetting, the stops will engage the green and red levers on the tuning controls as the controls are rotated. The positions of the red and green levers can be changed so that the stops will function for any desired detented frequency. To preset any two detented frequencies, perform the following steps:

a. Turn the MCS and TENTH MCS tuning controls until the higher of the desired frequencies is indicated on the tuning dials.

b. Pull on the stop adjusting knobs (against the spring tension which holds them locked against the panel) and turn the knobs so that the stops are positioned to engage the red and green preset levers. Make certain that the stops lock into position, that is, that the knob engages the locating pin.

c. Loosen, but do not remove the screw which secures the MCS tuning control.

d. Turn the green lever on the MCS control in a clockwise direction until it strikes against the stop. Hold the lever against the stop and tighten the screw on the tuning control.

e. Loosen, but do not remove the screw which secures the TENTH MCS tuning control.

f. Compare the tenth portions of the two frequencies which are to be preset and set the green preset lever on the TENTH MCS control in one of the following ways:

- (1) If the tenth portion of the higher preset frequency is higher than the tenth portion of the lower preset fre-

quency, turn the green lever in a clockwise direction until it strikes the stop. Hold the lever against the stop and tighten the screw on the tuning control.

- (2) If the tenth portion of the higher preset frequency is lower than the tenth portion of the lower preset frequency, turn the green lever in a counterclockwise direction until it strikes the stop. Hold the lever against the stop and tighten the screw on the tuning control.

g. Turn the MCS and TENTH MCS controls until the lower of the desired frequencies is indicated on the tuning dials.

h. While holding the green lever in place, loosen the screw on the MCS tuning control and turn the red lever in a counterclockwise direction until it strikes the stop. Tighten the screw on the tuning control.

i. The setting of the red lever on the TENTH MCS control depends on the setting of the green lever (*f* above). If the green lever was set in a counterclockwise position, set the red lever in a clockwise position, and vice versa.

*Note.* In describing the presetting procedure, it has been assumed that the green preset levers would be used for the higher frequency and the red levers would be used for the lower frequency. The opposite convention is equally suitable, but consistency in either convention is desirable.

#### 55. Continuous Tuning of Receiver-Transmitter

Continuous tuning throughout the range of the receiver-transmitter is possible by releasing the channel-detent and preset mechanisms of the TENTH MCS dial.

a. Turn the MCS control (as for channel tuning) until the MCS dial indicates the integral portion of the desired frequency.

b. Turn the TENTH MCS control to the extreme counterclockwise position to release the detent mechanism.

c. Turn the TENTH MCS control clockwise until the TENTH MCS dial indicates the decimal portion of the desired frequency. (Calibration marks between the major 100-kc (.1 mc) divisions represent 25-kc (.025 mc) intervals; when the MCS dial indicates 24, a frequency of 24.85 is selected by turning the TENTH MCS control until the second calibra-



tion mark between 8 and 9 appears under the hair-line on the TENTH MCS dial).

56. Tuning Auxiliary Receiver

a. *Tuning and Calibrating.* When the auxiliary receiver is turned, it should be calibrated at the nearest calibration point. Perform the following steps:

- (1) Apply power to the receiver by turning the receiver VOLUME control in a clockwise direction.
- (2) Provide a means of monitoring. (A headset on the panel AUDIO connector or on a convenient interphone box.)
- (3) Turn the TUNING control until the calibration frequency nearest to the desired frequency is indicated on the CHANNEL dial. The calibration frequencies for the respective receivers are shown in the following chart; they are indicated on the dial by red dots.

Radio set	Radio receiver	Calibration frequencies
AN/VRC-20..	R-108/GRC....	21.5 and 25.8 mc.
AN/VRC-21..	R-109/GRC....	30.1, 34.4, and 38.7 mc.
AN/VRC-22..	R-110/GRC....	38.7, 43.0, 47.3, and 51.6 mc.

- (4) Turn the SQUELCH control to OFF.
- (5) Hold the TUNE-DIAL LIGHT (ON-OFF) switch to the TUNE position and listen for a beat note or zero-beat indication in the headset. Adjust the TUNING control slightly, if necessary, until the zero-beat indication is obtained. The zero beat is an indication that the receiver is tuned to the calibration frequency. (If the dial setting is incorrect, it can be corrected mechanically by turning the screw which holds the dial. The correction screw is located under the diamond-shaped plate beneath the channel dial.)
- (6) Turn the TUNING control until the

desired frequency is indicated on the CHANNEL dial.

b. *Presetting.* Provisions are available for presetting any three frequencies. Perform the following steps.

- (1) Loosen both thumbscrews on the diamond-shaped plate (fig. 6) beneath the CHANNEL dial. Swing the plate out of the way to allow access to the detent adjustments beneath the plate.
- (2) Turn each of the detent adjustment screws in a counterclockwise direction to release all previous adjustments. Turn the TUNING control from one end of its range to the other to make all the detents available.
- (3) Calibrate and tune the receiver to one of the desired frequencies as outlined in a above.
- (4) Turn the DET A adjustment screw in a clockwise direction to set the detent mechanism for the frequency selected.
- (5) Check the tuning at the detented frequency when a signal is received. If the signal is distorted it may be possible to refine the tuning by adjustment of DETENT VERNIER A on the panel of the receiver.
- (6) Repeat the steps outlined in (3), (4), and (5) above for each of the other desired frequencies, using the DET B and DET C controls and DETENT VERNIER B and C controls.

*Note.* When the dial is set to a detented channel, a small flag drops down into position in the upper part of the window. The flag is identified by the letter (A, B, or C) of the detent adjustment which has been used to preset that particular frequency.

- (7) To reset only one of the preset frequencies, turn the TUNING control to the frequency that is no longer to be used, and turn its respective detent adjustment screw counterclockwise. Reset the TUNING control to the desired frequency and turn the detent adjustment screw in a clockwise direction to set the detent mechanism.

Section IV. OPERATION

57. Operational Procedures

a. Operation of the radio sets involves the

following procedures:

- (1) Start-stop operations.

- (2) Squelch adjustments.
- (3) Volume-level adjustments.
- (4) Tuning
- (5) Transmit-control operations.

b. The procedures listed in *a* (1) through (4) above are local operations (performed at the panels of the various major units) and are not repeated necessarily during normal operating periods. (It may be necessary to repeat the tuning and the squelch adjustments as occasion demands). The transmit-control operations usually are performed at Control Box C-375/VRC and are repeated continually during normal operating periods. If desired, the receiver-transmitter may be operated completely from the panel of the receiver-transmitter. When the tactical situation requires it, start-stop control and transmit control can be extended to a remote station (par. 137) by means of Control Group AN/GRA-6 (auxiliary equipment).

## 58. Starting Procedure

- a. Turn the OPERATE switch of the receiver-transmitter power supply to the TRANS & RECEIVE position.
- b. Turn the VOLUME control of the auxiliary receiver to its midpoint position.
- c. Turn the TRANS POWER switch of the receiver-transmitter power supply to the HIGH or LOW position, depending on the range of transmission required.
- d. Turn the SQUELCH controls of the receiver-transmitter and the auxiliary receiver to their maximum clockwise positions.

## 59. Squelch and Volume Level Adjustments

The SQUELCH and VOLUME controls of the receiver-transmitter and the auxiliary receiver should be set as soon as the equipment is placed in operation. The SQUELCH control setting should be checked periodically to insure operation at maximum sensitivity for the particular noise condition present. Set the controls as outlined in *a* and *b* below.

- a. Provide a monitor for the receivers by connecting a chest set (with handset and microphone) to one of the AUDIO connectors of Control Box C-375/VRC. Turn the VOL. control associated with the connector to the ap-

proximate midpoint of its range. Turn the selector switch on the control box to the counterclockwise position. Repeat the connections and settings for each control box used.

b. Turn the receiver-transmitter SQUELCH control counterclockwise until noise is audible in the headsets. Advance the VOL. control on the control box to obtain a comfortable listening level in the headsets, then advance the SQUELCH control in a clockwise direction to the point at which the receiver quiets.

c. Repeat the steps outlined in *b* above, adjusting the SQUELCH control for the auxiliary receiver.

*Note.* When the tuning of a unit is changed, it may be necessary to reset its SQUELCH control.

## 60. Frequency Selection

After the TUNING control is set to the desired frequency, it is necessary to check for interference between the receiver-transmitter and the auxiliary receiver. If interference is present either on the receiver-transmitter or the auxiliary receiver, tune one or both units to different operating frequencies until this interference is eliminated or minimized.

a. The references for setting the TUNING control of the receiver-transmitter are as follows:

- (1) To select a detent channel, follow the procedure outlined in paragraph 53.
- (2) To preset a detented channel, follow the procedure outlined in paragraph 54.
- (3) To tune to a frequency which lies between detented channels, follow the procedure outlined in paragraph 55.

b. The references for setting the TUNING control of the auxiliary receiver are as follows:

- (1) To preset a frequency, follow the procedure outlined in paragraph 56b.
- (2) To tune to a frequency which lies between preset frequencies, follow the procedure of paragraph 56a (6).

## 61. Operation from Control Box C-375/VRC

a. *Modes of Operation.* When power has been supplied to the radio set and squelch- and volume-level adjustments have been made, and when the frequency of operation has been se-



lected, monitoring and push-to-talk operations are possible at Control Box C-375/VRC.

*b. Connection of Audio Accessories.* For both modes of operation, Chest Set Group AN/GSA-6 is connected to one of the audio connectors on the control box, and Headset-Microphone H-63/U is connected to the chest set. Lock the RADIO TRANS. switch of the control box in the RADIO TRANS. position and turn the selector switch to the counterclockwise position.

*c. Monitoring.* The combined signals of both receivers will be audible in the headset when the audio accessories have been connected and the switches have been set as outlined in *b* above. To vary the signal level in the headset, adjust the VOL. control next to the audio connector being used.

*d. Radio Push-to-Talk Operation.* For push-to-talk operation of the receiver-transmitter, press the RADIO-INT button and either of the push-to-talk buttons (LOCK-ON or HOLD-ON) on the chest set and talk into the microphone. Release the push-to-talk button to listen. To release the LOCK-ON button, momentarily press the HOLD-ON push-to-talk button.

*Note.* If desired, the LOCK ON push-to-talk button may be disabled by turning the adjustable stop (fig. 28) so that it blocks the push-to-talk rocker arm.

*e. Interphone Push-to-Talk Operation.* Set the Selector switch at its counterclockwise position. Press the push-to-talk button to talk. Release to listen. (*Do not press the RADIO-INT button.*)

## 62. Operation from Unit Panel

*a. Receiver-Transmitter.* The receiver-transmitter can be operated locally by using a handset or a chest set (with headset and microphone) connected to an AUDIO receptacle on the panel of the receiver-transmitter. Since there are two AUDIO connectors on the panel of the receiver-transmitter, a microphone and headset or microphone and loudspeaker may be used. Ringing facilities, as well as monitoring and push-to-talk facilities, are available at the panel.

- (1) *Starting procedure.* Power must be supplied to the set, squelch- and volume-level adjustments must be made, and frequency of operation

must be selected as outlined in paragraphs 58, 59, and 60. Received signals then will be audible in the headset, earpiece or loudspeaker.

- (2) *Ringling.* To transmit a 1,600-cycle ringing signal, hold the DIAL LIGHT (ON-OFF)-RING switch in the RING position. Release the switch to listen. When the ringing signal has been acknowledged, proceed on a push-to-talk basis.
- (3) *Push-to-talk operation.* Press the RADIO-INT button and the push-to-talk button on the chest set, or the push-to-talk button on the handset, or microphone and talk into the microphone (or mouthpiece). Release the button to listen.

**Caution:** If the push-to-talk button on the chest set, handset, or microphone used with the set is pressed accidentally when the OPERATE switch on the receiver-transmitter power supply is in the RECEIVE position, the set will transmit a distance of about two miles. Therefore, when the tactical situation is such that it is dangerous to transmit accidentally, use an audio accessory for monitoring which does not have a push-to-talk button, such as a pair of phones or a speaker.

*Note.* Later models of the receiver-transmitter power supply are modified so that it is impossible to transmit when the OPERATE switch of the receiver-transmitter power supply is in the RECEIVE position (TM 11-5036).

*b. Auxiliary Receiver.* The auxiliary receiver can be monitored locally by connecting a headset or loudspeaker to the AUDIO connector on the front panel.

## 63. Stopping Procedure

*a.* To cut off all power from the radio set, set the OPERATE switch of the receiver-transmitter power supply at OFF and the VOLUME switch of the auxiliary receiver at OFF position.

*b.* To make only the transmitter inoperative, set the OPERATE switch of the receiver-transmitter power supply in the RECEIVE position.



## CHAPTER 4

### THEORY OF OPERATION

#### Section I. INTRODUCTION

##### 64. General

a. System theory is presented to provide an understanding of how the several units are interrelated in the various operations of the radio sets. Such an understanding should be an effective aid in trouble shooting the equipment to isolate a defective unit and, in some cases, to isolate a defective part within a unit.

b. Detailed circuit theory of individual units is not discussed, except for those portions of the units which are interconnected in a common circuit. For example, the microphone circuits of the receiver-transmitter are described since they are interconnected with the control units through the mounting. Details of the receiver-transmitter i-f amplifier are not important for system understanding and therefore are not discussed. Most of the information presented in this chapter is concerned with system applications of the several units. Complete details on the individual units are published in separate technical manuals. To provide a general acquaintance with the individual units, however, block diagrams of the major units are included and schematic diagrams of all units are found at the end of the manual.

##### 65. Basic System Block Diagram

a. Basically each of the radio sets consists of a receiver-transmitter, an auxiliary receiver, and an interphone amplifier, with speech-input and monitoring facilities as shown in figure 34. The output of the auxiliary receiver is paralleled with the receiver output of the receiver-transmitter. These basic units are the essentials of the systems, and the power supplies, cables, mountings, and miscellaneous equipment are supplied to make the basic units perform their function of transmitting, receiving, or monitoring.

b. In an actual system installation, microphone and headset facilities are provided at each interphone box (Control Box C-375/VRC). The switching provisions on the box allow selection of the more of operation, namely, transmission, interphone operation, or monitoring. The control facilities are extended from the individual units to the interphone box through Mounting MT-297/GR and interconnecting cables (fig. 27).

c. Auxiliary equipments can be used with Radio Sets AN/VRC-20, -21, and -22 to provide additional facilities. Control Group AN/-

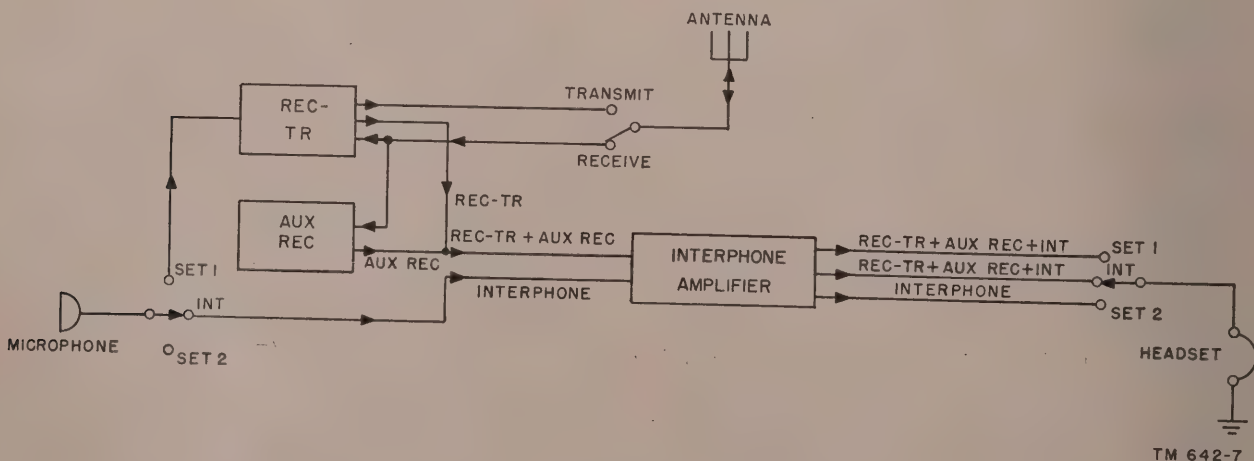


Figure 34. Basic system block diagram.

GRA-6 provides for remote control of the radio set and for duplex telephone operation between operators at the local and remote control units of this equipment. Modification Kit MX-898/GR provides the components necessary for temporary operation of an individual receiver-transmitter when it is located in the field away from a vehicular source of power (vehicular storage battery). These auxiliary facilities are described in paragraphs 112 through 152.

## 66. System Diagrams

Three diagrams (figs. 94, 95, and 96) are used to illustrate system interconnections and functioning. The diagrams make it possible to follow, on a single schematic, a circuit which originates in one unit and passes through one or more other system units. The system power distribution schematic diagrams are shown on figures 94 and 95. The system monitoring circuits are shown on figure 96. The power distribution circuit is discussed in paragraphs 68 through 72 with the aid of illustrations which are portions of the system power distribution schematic diagram. This makes it easier to follow the circuit discussion with reference to the diagram. Monitoring and push-to-talk facilities are discussed in similar fashion in paragraphs 73 through 79.

## 67. System Legend

a. A system legend is used on the system diagrams (figs. 94, 95, and 96) to aid in tracing each circuit from one unit to another. As indicated on the legend, a letter has been used to identify each unit. This letter has been prefixed to the reference symbol of the part in a particular unit. Thus, in the reference symbol, H/P-5B at the upper left-hand corner of figure 94, H indicates Mounting MT-297/-GR, P-5 indicates a plug on the mounting (the termination of one of the mounting cables), and B indicates terminal B of the plug. The connection from H/P-5B to D/J-6B indicates that terminal B of plug P-5 on mounting MT-297/GR is connected to terminal B of receptacle J-6 on AF Amplifier AM-65/-GRC. The complete legend as shown on each system diagram is listed below.

Legend	
Unit symbol	Unit symbolized
A	Receiver-Transmitter RT-66/GRC, RT-67/-GRC, or RT-68/GRC (Set 1).
D	AF Amplifier AM-65/GRC (interphone amplifier).
E	Power Supply PP-109/GR or PP-112/GR (Set 1 power supply).
G	Radio Receiver R-108/GRC, R-109/GRC or R-110/GRC (auxiliary receiver).
H	Mounting MT-297/GR.
M	Remote Control C-433/GRC (auxiliary equipment).
N	Local Control C-434/GRC (auxiliary equipment).
R	Control Box C-375/VRC (control box).
T	Handset H-33/PT.
U	Power Supply PP-281/GRC or PP-282/GRC (interphone amplifier and auxiliary receiver power supply).
V	Special Purpose Cable Assembly CX-1211/U.
W	Special Purpose Cable Assembly CX-1213/U.
Y	Chest Set Group AN/GSA-6.

b. The following chart gives the correlation between the physical and electrical interconnections made between the mounting and other units. These interconnections are shown on figures 19 and 27.

Mounting cable	Cable termination	Mating connector		
		Receptacle	Unit	Receptacle designation
W-1	P-1	J-6	Auxiliary receiver.	POWER IN
W-2	P-2	J-8	Auxiliary receiver	REC
W-3	P-3	J-312	Set 1.	CONTROL REC-TR CONTROL
W-4	P-4	J-6	Interphone amplifier.	POWER IN
W-5	P-5	J-6	Set 1 power supply.	POWER IN
W-6	P-6	J-4	Interphone amplifier.	REC-TR CONT
W-7	P-7	J-2	Interphone amplifier.	INT CONT
W-8	E-8 & E-11		Battery.	

c. To facilitate location of parts discussed in the text, the system diagram incorporates a coordinate system similar to that used on automobile road maps. A part to be located is

followed by the coordinate letter and number inclosed in parentheses. Through the use of the letter and number, the reader readily can locate the part on the diagram. For example, contacts 2 and 3 of relay D/O-1 are located on figure 94 by the coordinates (G, 28).

- (1) Find the index letter G at the left- or right-hand margin of the diagram.
- (2) Find the index number 28 at the top

or bottom margin of the diagram.

- (3) The contacts will be found in the general area of the intersection of a line drawn vertically from 28 with a line drawn horizontally from G. (Of course these lines need not be drawn but may be visualized with sufficient accuracy to locate the desired part).

## Section II. POWER DISTRIBUTION

### 68. General

a. In this section, the power distribution system common to Radio Sets AN/VRC-20, -21, and -22 is described. Paragraph 69 describes the connections from the battery through the mounting to the power cables which connect with the system units. Paragraphs 70 through 72 describe the connections from the power cables of the mounting through each of the units of the radio set.

b. Partial schematic diagrams (figs. 35 through 41) are presented to aid in understanding the discussion. The diagrams are portions of the main system power distribution circuit (fig. 94). Figure 95 is similar to figure 94 except that the circuits through Control Group AN/GRA-6 (auxiliary equipment) are shown instead of those through Control Box C-375/VRC.

### 69. Primary Power Application (fig. 35)

The OFF-REMOTE-ON switch (H/S-1) in the mounting controls application of power to the system. When this switch is at ON a circuit is completed from the battery, through fuses H/F-1 and H/F-2, the front section of the OFF-REMOTE-ON switch, the coil of relay H/K-1, resistor H/R-3, and the rear section of the OFF-REMOTE-ON switch to ground. The negative side of the battery is grounded through H/E-11 and H/E-12. When the OFF-REMOTE-ON switch is set at REMOTE, the circuit is the same except that the second section of the switch completes the circuit to terminal H/J-1M. This terminal is connected to ground through Control Group AN/GRA-6 when the controls on that equip-

ment are set to turn power on (par. 82). H/R-3 is a voltage dropping resistor which allows 12 volts to be applied to the coil when a 24-volt battery is used as the voltage source. When a 12-volt battery is used, a jumper is placed

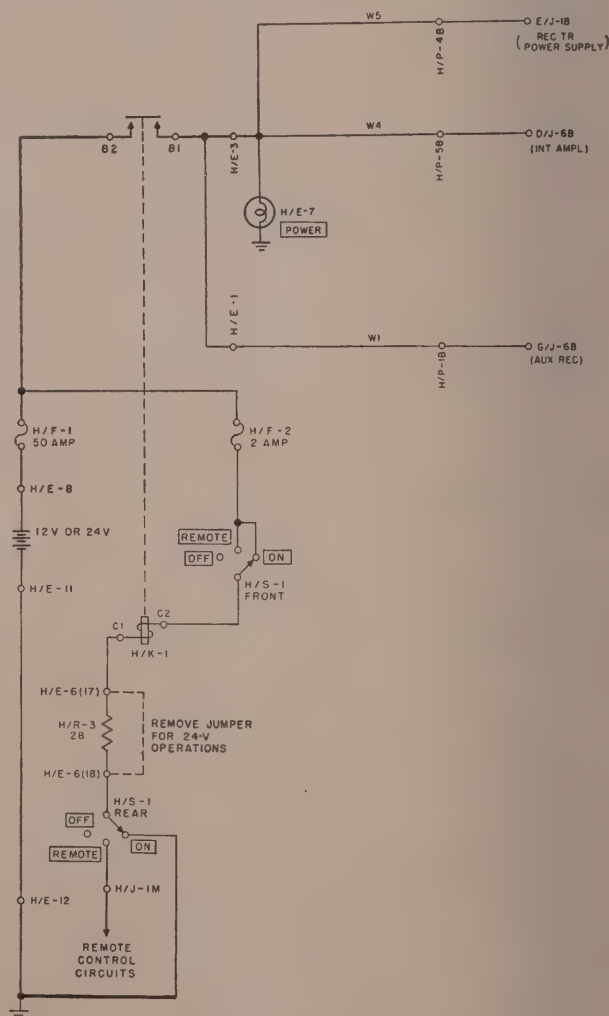


Figure 35. Primary power application, schematic diagram.

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across H/R-3. This allows the coil of H/K-1 to receive the full 12 volts necessary to operate it. The coil of relay H/K-1 is energized and its contacts close to complete the positive side of the battery to four branch circuits.

a. In the first branch, battery voltage is applied through H/E-1, cable W-1, and H/P-1B to G/J-6B (on auxiliary receiver).

b. In the second branch, battery voltage is applied through H/E-3, cable W-4, and H/P-5B to D/J-6B (on interphone amplifier).

c. In the third branch, battery voltage is applied through H/E-3, cable W-5, and H/P-4B to E/J-1B (on receiver-transmitter power supply).

d. In the fourth branch, the battery circuit is completed to ground through H/E-3 and H/E-7. H/E-7, the POWER lamp on the mounting, lights to indicate that voltage is available at the terminals of the mounting.

## 70. Receiver-Transmitter Power Distribution Circuits (figs. 94 and 95)

a. *Power Input Circuits.* Four-section OPERATE switch E/S-1 on the panel of the receiver-transmitter power supply, acts as a power (on-off) switch for the receiver-transmitter. Battery potential is supplied to the switch through E/J-1B. When the switch is set in either the RECEIVE or the TRANS & RECEIVE position, the receiver-transmitter is ready for monitoring. Operation is the same for both positions as long as no transmit control switch is operated.

*Note.* With most models of the receiver-transmitter power supply, when the OPERATE switch is at RECEIVE, pressing the push-to-talk switch (on a handset or chest set) energizes the transmit-control relay A/O-101. This operates the transmitter reactance modulator stage (V-105 and V-106), the oscillator (V-104A), the mixer (V-6), and the r-f stage (V-7 and V-8). (If the TRANS-POWER switch on the power supply is at LOW, the transmitter driver stage (V-9 and V-10) also operates). This makes it possible to transmit accidentally by pressing the push-to-talk button even when the OPERATE switch of the power supply is in the RECEIVE position. With some of the later models of the receiver-transmitter power supply, pressing the push-to-talk switch does not energize the transmit-control relay and it is impossible to transmit when the OPERATE switch is in the RECEIVE position (TM 11-5036).

b. *Transmit Control Circuits* (fig. 36). The distribution of power to either the transmitter or the receiver sections of the receiver-transmitter is controlled by three relays, A/O-1, A/O-101, and A/O-301. When these relays are energized they transfer the receiver-transmitter from the receive to the transmit condition. The relays are energized when a push-to-talk switch is operated or when the DIAL LIGHT (OFF-ON)-RING switch is set at RING.

- (1) Battery voltage is applied to the three relay coils (which are connected in parallel) through terminal E/J-1B, the RECEIVE or the TRANS & RECEIVE positions of switch E/S-1D, fuse E/F-1, coil E/L-4, voltage-dropping resistor E/R-30, and coil E/L-15. E/R-30 has a value of 45 ohms in Power Supply PP-112/GR which is used with a 24-volt battery supply and a value of 16 ohms in Power Supply PP-109/GR. In either case, the voltage applied across the relay coils is dropped to a value of approximately 6 volts.
- (2) The ground return for the relay coils is made through one of several paths. The most commonly used path (fig. 36) is through the Set 1 position of R/S-1C rear, through either one of the RADIO TRANS. (closed) position of R/S-2B, through the RADIO positions of Y/S-1, and through Y/S-2 (the push-to-talk switch) to ground. When the circuit is completed to ground, the relays are energized. Alternate ground returns may be established through the RING position of the DIAL LIGHT (OFF-ON)-RING switch, or through a push-to-talk switch associated with control C-434/GRC or the control panel of the receiver-transmitter.
- (3) The antenna plugs into ANT jack A/J-307. This jack is connected to contact 4 of relay A/O-301. Normally, the antenna is connected through contacts 4 and 3 of A/O-301 to the auxiliary receiver and to the receiver section of the receiver-transmitter. When A/O-301 is energized, contacts 4 and 3 open and contacts 4 and 5

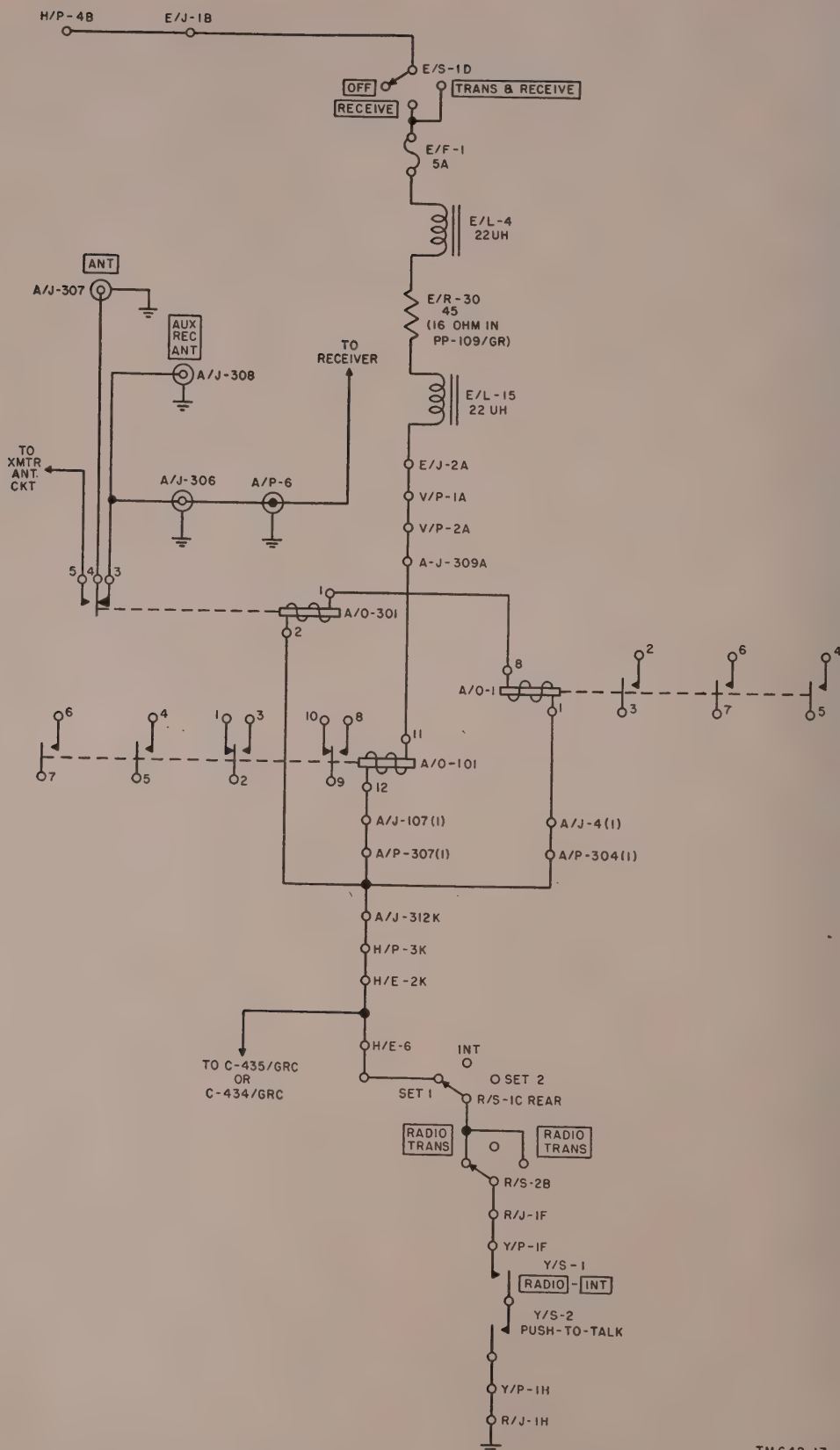


Figure 36. Transmit control circuits.

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close. This disconnects the antenna from the auxiliary receiver and the receiver section of the receiver-transmitter, and connects the antenna to the transmitter section of the receiver-transmitter.

- (4) The contacts of A/O-101 are used to complete circuits in the receiver section of the receiver-transmitter when this relay is not energized, and to break these circuits and complete circuits in the transmitter section and through the coil of relay E/O-1 when A/O-101 is energized.
- (5) The contacts of A/O-1 are used to complete circuits in the transmitter when this relay is energized.

*c. Filament Circuits* (fig. 37). Switch E/S-1D extends battery potential to four circuits originating in the receiver-transmitter power supply (fig. 37). Two of the circuits, that of relay E/O-1 and that of the transmit control relays, do not contain filament elements, but are concerned with the application of power to the transmitter filaments. The operations and functions of the relays are discussed in connection with the transmit-control circuits (par. *b* above and 75). The remaining two circuits contain the receiver-transmitter filaments and the dial light circuit.

- (1) Current is supplied to the filaments of the receiver tubes, the crystal oscillator-harmonic generator, and the first harmonic amplifier through a protection circuit within the receiver-transmitter power supply. The filament circuits completed are those of tubes A/V-1 through V-4, A/V-101 through V-103, and A/V-107 through V-116. Complete circuit details of the series-parallel filament arrangement are shown in figure 83.
- (2) The filament protection circuit for the receiver filaments is similar in design and operation to the protection circuits used throughout the system. The protection circuit prevents damage to the tubes due to excessive filament current and provides a constant 6.3-volt potential drop for the filaments. The circuit contains a thermal relay, E/K-2, which adds a resistance in

series with the filaments when a dangerous voltage increase occurs. The added resistance is sufficient to drop the filament voltage to a safe level and render the receiver inoperative. The action of the ballast tubes, E/R-40 and E/R-31, within the protection circuit tends to maintain a constant current through the circuit and therefore a constant voltage available for the filaments. The tubes act as variable resistors, their resistance varying with the voltage applied. If the source voltage decreases, the tube resistance and voltage drop decrease, resulting in a more constant filament potential. Power Supplies PP-109/-GR and PP-112/GR are used for 12- or 24 volt operation, respectively. The arrangement of circuit components is shown on figure 37.

- (3) The dial light circuit is connected in parallel with the filaments of A/V-113 and V-114. In the OFF position of DIAL LIGHT (OFF-ON)-RING switch A/S-302, a dummy load resistor, A/R-304 is inserted in place of the LAMP, to maintain a constant drain on the filament circuit. This is necessary to insure system stability.
- (4) Current is supplied to the filament circuits of the transmitter through contacts 2 and 3 of relay E/O-1, through ballast tubes E/R-37, E/R-38, E/R-24, and E/R-25, through a protection circuit within the power supply, thermal relay E/K-1, and through normally open contacts 5 and 4 of relay A/O-101. The ground line of relay E/O-1 is completed through normally open contacts 6 and 7 of transmit-control relay A/O-101. This arrangement allows the application of potential to the transmitter filaments only when the transmitter is operated. The filament circuits completed are those of tubes A/V-5 through V-11 and A/V-104 through V-106. The receiver-transmitter microphone control line which parallels the transmitter filament circuits is discussed in connection with the transmit-control





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circuits (par. 75).

- (5) The protection circuit for the transmitter filaments is similar to that used for the receiver filaments. The parallel ballast tubes are necessary because of the greater current flow through the transmitter filaments.

*d. Plate and Screen Circuits* (figs. 38 and 39). The plate and screen potentials of the receiver-transmitter are supplied by three vibrators within the receiver-transmitter power supply. Two of the vibrators, with output voltages of 150 and 300 volts, supply transmitter tube circuits only (fig. 39). The low voltage of 85-volt vibrator supplies both transmitting and receiving tube circuits (fig. 38 and 39). The 150-volt vibrator input circuit includes the TRANS & RECEIVE position of E/S-1B, fuse E/F-3, r-f filter choke E/L-6, normally open contacts 7 and 8 of E/O-1, and voltage dropping resistor E/R-15. The 300-volt vibrator input circuit is completed only for high power transmission. The circuit includes the TRANS & RECEIVE position of E/S-1A, the HIGH position of TRANS POWER switch E/S-2B, fuse E/F-4, r-f filter choke E/L-7, normally open contacts 9 and 10 of relay E/O-1, and voltage dropping resistor E/R-3. Two relays, A/O-101 and A/O-301, within the receiver-transmitter render the receiver inoperative when the transmitter is functioning, by removing potential from some of the receiver tubes and by switching the antenna from the receiver input to the transmitter output. Low or high power transmission is selected by the TRANS POWER switch (E/S-2A and E/S-2B) which is used to change the potentials supplied to some of the transmitter plate and screen circuits.

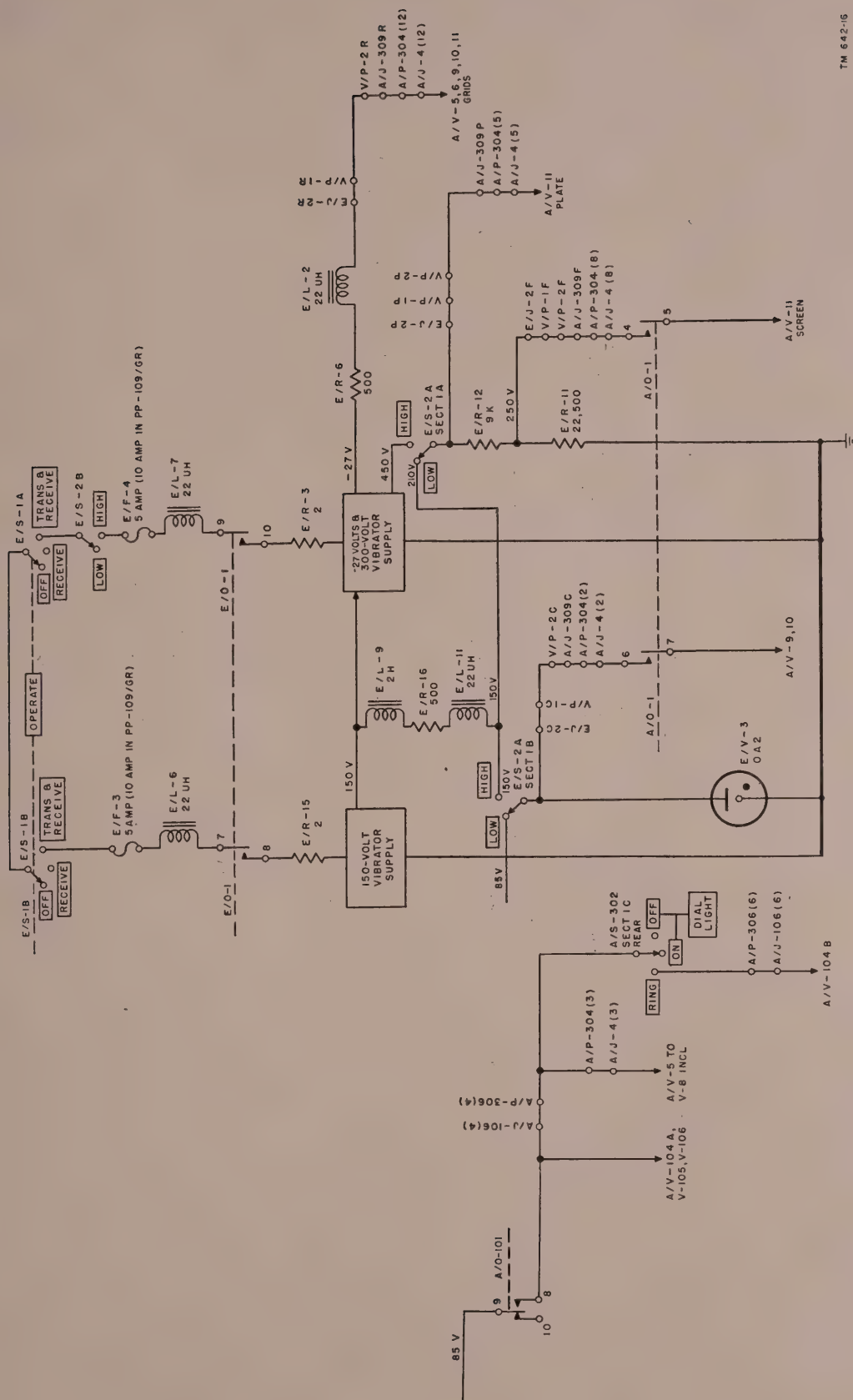
- (1) *Receiving circuits.* Battery potential is applied to the 85-volt vibrator through switch E/S-1C (fig. 38). The 135-volt output of this vibrator is supplied through r-f filter choke E/L-12 and voltage dropping resistor E/R-17 to the second a-f amplifier, A/V-116, and through voltage dropping resistors E/R-21 and E/R-22 to a voltage regulation circuit within the power supply. E/R-21 is shorted out during transmitting periods by the closure of contacts 4 and 5 of relay E/O-1.

This compensates for the increased drain of the transmitter tubes which are energized when contacts 9 and 8 of relay A/O-101 close. E/R-22 is shorted out by section 1C of switch E/S-2A (TRANS POWER) when this switch is in the LOW position. This compensates for the increased drain of the transmitter driver tubes, A/V-9 and V-10 which operate from the 85-volt supply when the TRANS POWER switch is at LOW. From the regulation circuit, an 85-volt potential is made available to plate and screen circuits of both the receiver and the transmitter. During reception, potential is supplied to the plate and screen circuits of tubes A/V-1 through V-4, A/V-101 through V-103, A/V-107 through V-112, and A/V-115. The plate and screen voltage for A/V-1 and screen voltage for A/V-2 are applied through normally closed contacts 9 and 10 of relay A/O-101. The plate voltage for A/V-2 is routed through dropping resistor A/R-133, a filter circuit (A/R-131 and A/L-117), and interchassis coaxial cable connectors A/J-101 and A/P-1. Screen voltage for squelch oscillator A/V-103 is applied through SQUELCH potentiometer A/R-302B and contacts of SQUELCH switch A/S-303. Adjustment of the potentiometer changes the screen potential of A/V-103, which varies the output level of the squelch oscillator. The extreme counterclockwise position of A/S-303 is the OFF position. In this position, switch A/S-303 is open, screen voltage is not applied to A/V-103 and the squelch circuit is disabled. The plate and screen potentials for retransmit (fixed level) audio A/V-102 and first audio amplifier A/V-115 are supplied through voltage-dropping resistor A/R-177. The circuit for A/V-115 passes through normally closed contacts 5 and 4 of relay H/O-1 when the retransmission unit (Control C-435/GRC) is not plugged into the mounting. When the retransmis-

(2) *Transmitting circuits* (fig. 39). The plates and screens of all transmitting tubes are supplied with potential after relays E/O-1, A/O-101, and A/O-1

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Figure 39. Transmitter plate circuits of receiver-transmitter.

A/V-1 and the screen of first receiver mixer A/V-2). The other tubes in the receiver remain operative to permit completion of the sidetone circuit. When relay A/O-101 is energized, contacts 8 and 9 close to energize all tubes of the transmitter except transmitter drivers A/V-9 and V-10 and power amplifier A/V-11. The circuits to the driver and power amplifier stages of the transmitter are described in (a) and (b) below.

- (a) *High power transmission.* When TRANS POWER switch E/S-2 is placed in the HIGH position, the plate circuit of the power amplifier, A/V-11, is supplied with a 450-volt potential obtained by the series connection of the 150- and 300-volt vibrators. Resistors E/R-12 and E/R-11 form a voltage divider which applies 250 volts to the screen of A/V-11 through contacts 4 and 5 of A/O-1. The 150-volt vibrator output is applied, through E/L-9, E/R-16, and E/L-11, the HIGH position of section 1B of E/S-2A and contacts 6 and 7 of A/O-1 to transmitter drivers A/V-9 and V-10. A 27-volt potential from the 300-volt vibrator supplies grid bias through E/R-6 and E/L-2 to tubes A/V-5 (second harmonic amplifier), A/V-6 (transmitter mixer), A/V-9, A/V-10, and A/V-11 during high power transmission.
- (b) *Low power transmission.* If the TRANS POWER switch (E/S-2) is set at LOW, the following circuit changes are effected: the input to the 300-volt vibrator supply is broken (E/S-2B); tube A/V-11 is switched from the 450-volt supply to the 150-volt supply by section 1A of switch E/S-2A; tubes A/V-9 and A/V-10 are switched from the 150-volt supply to the 85-volt supply; resistor E/R-22 in the 85-volt supply lead (fig. 38) is short-circuited to compensate for the increased drain of A/V-9 and V-10 on that supply.

## 71. Interphone Amplifier Power Distribution Circuits (fig. 40)

*a. Power Input.* OFF-INT-RT 70 switch D/S-2 controls the power input to the filament, plate and screen, and control circuits of both the interphone amplifier and a second receiver-transmitter (when used). The INT position of the switch energizes the interphone amplifier only, while the RT-70 position completes the power circuits to the interphone amplifier and a second receiver-transmitter (when used). When switch D/S-2 is placed in the INT position, battery voltage is extended from the POWER IN receptacle, D/J-6B, on the panel of the interphone amplifier to the amplifier filaments and the 135-volt plug-in power supply.

### *b. Filament Circuits.*

- (1) When 6V-12V-24V switch D/S-1 (the 6V position is not used) is in the 24V position, sections 1B and 1A of the switch place the filament protection circuit for a second receiver-transmitter (when used) in series with the amplifier filaments (D/V-1 through V-5). For 12-volt operation, sections 1B, 1D, and 1A of D/S-1 place the filament and protection circuits in parallel directly across the battery. Section 1A of D/S-2, when in the INT position, places dummy load resistor D/R-36 in parallel with a section of the filament protection circuit in place of the load a second receiver-transmitter (when used) would place on the circuit.
- (2) The input voltage for the 135-volt vibrator in the amplifier is supplied through terminals D/J-5(3) and U/X-1(3). The vibrator output circuits are discussed in *c* below.

*c. Amplifier Plate and Screen Supply.* The plug-in vibrator power supply develops 135-volt output which is applied to the amplifier (and a second receiver-transmitter when used) plate and screen circuits (fig. 40). The amplifier tubes (V-1 through V-5) are supplied directly from the output of the vibrator. Provisions are made through terminal D/J-6D (POWER IN) to substitute an external 135-volt source for the vibrator output.

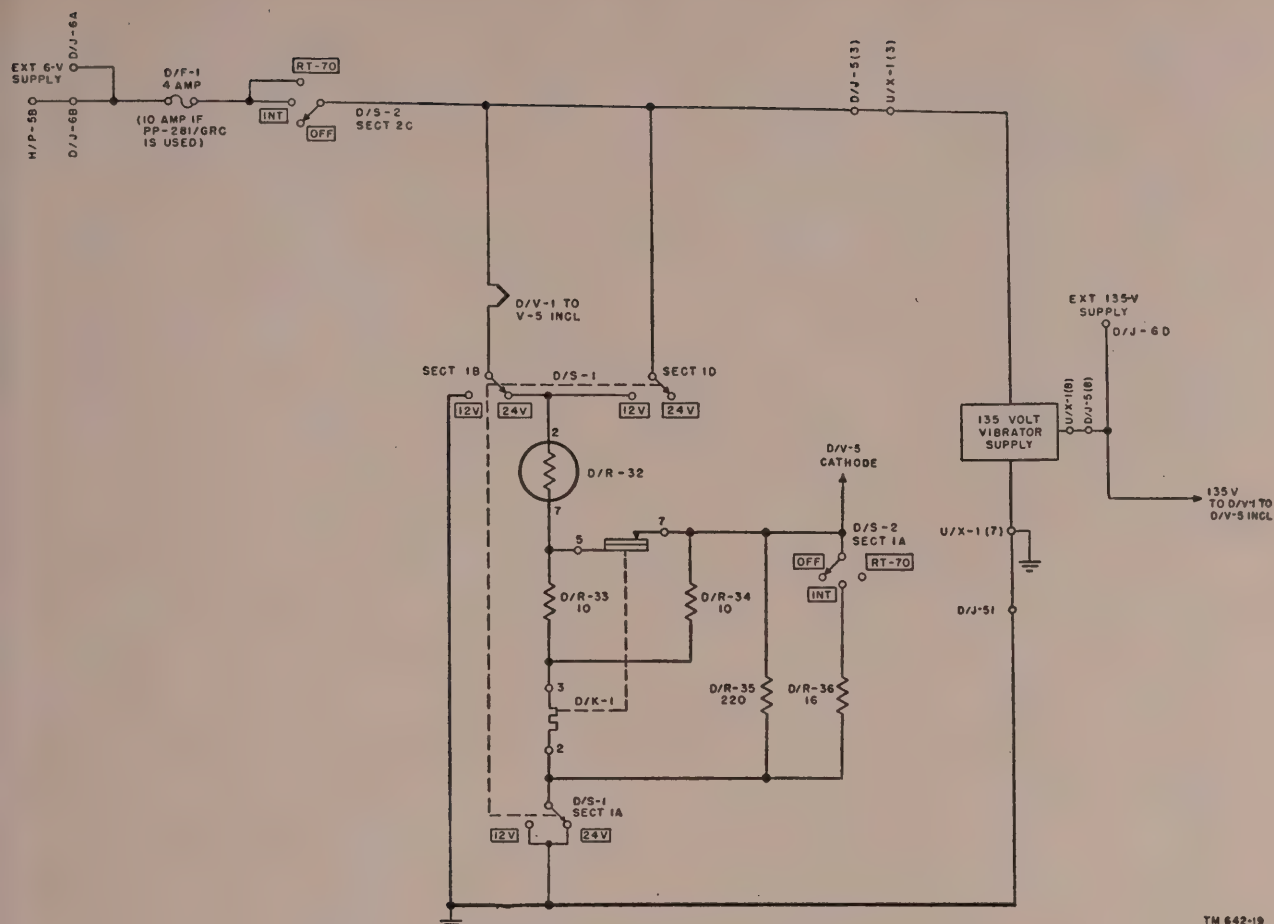


Figure 40. Interphone amplifier, power distribution circuits.

## 72. Auxiliary Receiver Power Distribution Circuits (fig. 41)

a. *Power Input.* Switch G/S-2, ganged to the VOLUME control on the panel of the auxiliary receiver, controls power application to the circuits within that unit. Turning the control clockwise from the OFF (extreme counterclockwise) position closes the switch and completes the battery circuit from POWER IN receptacle G/J-6B, through 4-ampere fuse G/F-1 and the switch, to the auxiliary receiver plug-in power supply (135-volt vibrator) and through two branches of voltage-dropping resistors to the tube filaments. Potential from the power supply is supplied to the plate and screen circuits.

b. *Filament and Dial Light Circuits.* The filament of G/V-14 is supplied through one circuit while the filaments of the remaining tubes and the dial light are supplied through a second circuit.

- (1) One circuit extends through resistors G/R-58, G/R-53, section 1A of switch G/S-1, the filament of G/V-14, and resistor G/R-50. When a 24-volt battery supply is used, plug-in Power Supply PP-282/GRC is used with the auxiliary receiver. This power supply is connected from terminal G/J-2(3) through U/X-1(3), U/X-1(6), and G/J-2(6) to resistor G/R-58. This resistor drops the voltage from approximately 24 volts to approximately 12 volts. When a 12-volt battery supply is used, plug-in Power Supply PP-281/GRC is used with the auxiliary receiver. Connections in this power supply from G/J-2(3) through U/X-1(3) and U/X-1(2) to G/J-2(2) by-pass resistor G/R-58. Thus approximately 12 volts is supplied to the same point in the receiver as when 24-volt battery supply is used. The 12 volts



at terminal G/J-2(2) is dropped through G/R-53 to approximately 6 volts at section 1A of switch G/S-1. (Provision is made for connecting an external 6-volt supply to this point in the receiver through terminal G/J-6A. However, the 6-volt supply is not

used with Radio Sets AN/VRC-20, -21, and -22.) When this switch is at the 6, 12, and 24 VOLT position, the 6 volts is applied through the two halves of the filament of G/V-14 (in parallel) and resistor G/R-50 to ground. G/R-50 produces a drop of

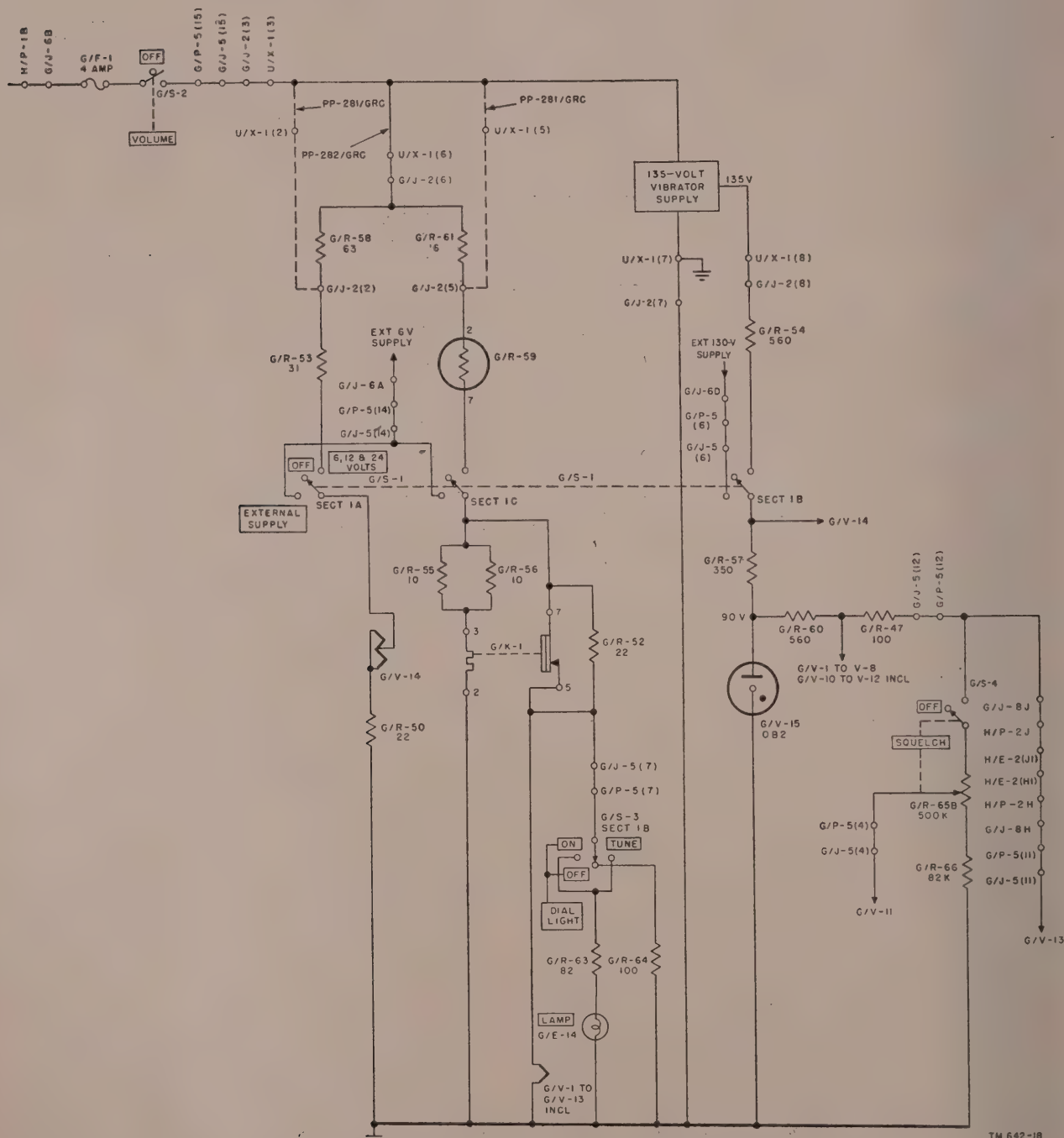


Figure 41. Auxiliary receiver power distribution circuits.

approximately 4.5 volts, leaving approximately 1.5 volts to be applied across each half of the filament of G/V-14.

- (2) The second circuit extends through resistors G/R-61 and G/R-59 (ballast tube) to section 1C of switch G/S-1. When a 24-volt battery supply is used, plug-in Power Supply PP-282/GRC is used. This makes connections to the receiver through resistor G/R-61 which drops the voltage to about 12 volts. When a 12-volt battery supply is used, plug-in Power Supply PP-281/GRC is used. This makes connections which effectively bypass G/R-61, and thus 12 volts is applied to the same point in the receiver as when a 24-volt battery supply is used. Ballast tube resistor G/R-59 drops the 12 volts to about 6 volts. It regulates against changes in current or voltage in this branch by increasing in resistance when the current tends to rise, and dropping in resistance when the current tends to fall. The 6 volts is applied through the 6, 12, & 24 VOLTS position of section 1C of switch G/S-1 through a filament protection circuit to the filaments of G/V-1 through V-13 and through section 1B of switch G/S-3 (the DIAL LIGHT (OFF-ON)TUNE switch) and voltage-dropping resistor G/R-63 and dial light G/E-14 to ground. The dial

light is connected in the circuit when the switch is either at ON or TUNE. When the switch is at OFF, the lamp is cut out of the circuit and dummy-load resistor G/R-64 is inserted in place of it to maintain a constant drain on the supply.

*c. Plate and Screen Supply.* Turning the VOLUME control clockwise from the OFF position closes G/S-2 and applies battery voltage to the vibrator of the plug-in power supply. The vibrator furnishes the plate and screen requirements of the auxiliary receiver tubes.

- (1) The 135-volt output of the vibrator is connected through voltage-dropping resistor G/R-54 and section 1B of switch G/S-1 to the plate and screen circuits of G/V-14 and to a voltage-regulation network. A 90-volt potential is supplied by the network to the remaining auxiliary receiver plate and screen circuits.
- (2) The network potential is supplied to tubes G/V-1 and through G/V-8, G/V-10 through G/V-12, and G/V-13 through dropping resistors in the network. The supply to G/V-13, the first audio amplifier, is also connected through switch G/S-4 (closed when the SQUELCH control is turned clockwise from the OFF) and SQUELCH potentiometer G/R-65B, to the screen of squelch oscillator G/V-11. The squelch potentiometer is completed to ground through resistor G/R-66.

### Section III. MONITORING AND PUSH-TO-TALK OPERATION

#### 73. General

*a.* A knowledge of the monitoring and push-to-talk facilities available is of prime importance to system understanding. The circuits which make possible those facilities are described in paragraphs 74 through 79.

*b.* Monitoring consists of listening to transmitted or received signals without making any attempt to communicate with the operator originating the signals. In the case of signals originating from a distant radio set, the received signal is picked up by the Set 1 receiver and routed through the system as shown

on figure 96. If the signal is being transmitted from the receiver-transmitter within the system to which the monitor's earpiece is connected, a sidetone circuit routes a portion of the signal back through the system for monitoring. The monitoring circuits are described in paragraph 74.

*c.* The receiver-transmitter included in the radio set is designed for push-to-talk operation. The switching of the receiver-transmitter from a monitoring (receiving) to a transmitting condition is accomplished by the contacts of three control relays within the unit, which render

the receiver inoperative and energize the transmitter circuits. The relays operate whenever a ground return line is provided for their energizing potential. This path is completed through the action of the push-to-talk switch or paralleling switches in one of the control units (pars. 70b and 75).

#### 74. Monitoring Circuits (fig. 96)

*a. General.* Provisions are made for both unit and system monitoring of the auxiliary receiver and receiver-transmitter in the radio set. Unit monitoring is performed by means of a headset or handset connected to one of the AUDIO receptacles of the receiver-transmitter or to the AUDIO receptacle of the auxiliary receiver. With this type of monitoring it is possible to hear only the signals being received or transmitted by the individual unit. System monitoring is possible at the control units and the interphone amplifier AUDIO receptacle. The signal distribution circuits from the receiver to all possible monitoring stations are shown on figure 96. The signal paths through the separate receivers and the interphone amplifier may be traced through the block diagrams of the units in question (figs. 43, 44, and 45). In the discussion which follows special emphasis is placed on the facilities available at each of the monitoring stations as well as on the system circuit.

##### *b. Monitoring at Panel of Receiver-Transmitter.*

- (1) The output of two different stages of the receiver section is used for monitoring at the panel. A low-level output of first audio amplifier stage V-115 is supplied to the A terminals of parallel AUDIO receptacles A/J-310 and A/J-311 for use with earphones. The high-level output of power amplifier V-116 is supplied to the L terminals of the above receptacles for connection to a loudspeaker. In a typical arrangement a loudspeaker may be connected to one of the AUDIO receptacles, while a low-level audio device (headset, handset, or chest set group) is connected to the second receptacle.

- (2) Only those signals being received or transmitted by the receiver-transmitter may be heard. A sidetone circuit (par. 85) diverts a portion of the transmission signal back through the receiver to the audio receptacle, making it possible to hear all signals transmitted by the receiver-transmitter.

##### *c. Monitoring at Panel of Auxiliary Receiver.*

A high- and low-level output is supplied to AUDIO receptacle G/J-7 of the auxiliary receiver (fig. 96). It is possible to monitor all signals passing through the receiver by means of an earpiece or a loudspeaker connected to the receptacle. Again as in the case of the receiver-transmitter panel, only unit monitoring is possible.

##### *d. Monitoring at Panel of Interphone Amplifier.*

- (1) An audio accessory connected to panel-mounted AUDIO receptacle D/J-1 of the interphone amplifier permits system monitoring at that point. The *all channel* circuit (containing the signals of all of the system units) supplies the amplifier receptacle. Terminals A and L provide circuit connections for phones or a loudspeaker respectively. A volume control on the panel permits adjustment of the signal-level of the interphone amplifier output.
- (2) The signal path from the fixed level amplifiers of the receiver-transmitter and the auxiliary receiver to the interphone amplifier is routed as shown on figure 96. The signals from the auxiliary receiver and the receiver-transmitter join within the mounting (terminals B1 and B of H/E-2) and are common throughout the remainder of the monitoring circuit. That portion of the circuit within the mounting includes contacts 2 and 3 of relay H/O-1.
- (3) Terminals D/J-1C and D/J-2C provide the input connection for the interphone microphone. The path of the signals through the interphone amplifier may be traced on the block diagram of that unit (fig. 44).



*e. Monitoring at Control Box C-375/VRC.*

- (1) An operator monitoring at one of the control boxes has a choice of three output channels of the amplifier (par. 87). When selector switch R/S-1 on the control box is in the center position he can hear the interphone, receiver-transmitter, and auxiliary receiver signals (the all channel position). When the switch is in the clockwise position, he can hear the interphone signal only. When the switch is in the counterclockwise position he can hear the receiver-transmitter, auxiliary receiver, and interphone signals. Provisions are made for using phones (jacks) or the usual audio accessories (receptacles) at the control boxes. The level of the signal appearing at the earpiece of the audio device can be adjusted by VOLUME controls, R/R-1 and R/R-2.
- (2) The path of the three amplifier output channels to the monitoring position at one of the control boxes is shown on figure 96. For further information concerning the signal channels, refer to the interphone amplifier unit theory (par. 87) or to TM 11-5039.

*f. Monitoring at Control Group AN/GRA-6 Auxiliary Equipment).*

- (1) It is possible to monitor all of the units comprising the system at both Local Control C-434/GRC and Remote Control C-433/GRC. The all channel path from the amplifier is completed to the local control unit as shown on figure 96. At the local unit an audio accessory connected to AUDIO receptacle N/J-1 permits monitoring of the system.
- (2) The circuit to the remote unit is coupled through two transformers (N/T-1 in the local unit and M/T-1 in the remote unit) and the telephone pair (fig. 95). An audio device connected to panel-mounted AUDIO receptacle M/J-1 (J, 35) of Remote Control C-433/GRC makes it possible to monitor the system.

## 75. Control Circuits (fig. 36)

*a. General.* Push-to-talk control of the receiver-transmitter is possible at the AUDIO receptacles of the receiver-transmitter, all of the control box positions (Control Box C-375/VRC), Local Control C-434/GRC, and Remote Control C-433/GRC (figs. 36, 94, and 95). Interphone push-to-talk control is possible at the AUDIO receptacle of the interphone amplifier and at any one of the control boxes. In the following discussion the relay and microphone circuits to the control positions are described.

*b. Relay Circuits (fig. 94).*

- (1) *Receiver-transmitter.* Application of energizing potential to the circuits containing the receiver-transmitter control relays is covered in paragraph 70b and is shown on figures 36 through 39. The three control relays of the receiver-transmitter (A/O-1, A/O-101, and A/O-301) are supplied with energizing potential from the receiver-transmitter power supply. The ground side of the relay is connected to the two AUDIO receptacles of the receiver-transmitter (A/J-310F and A/J-311F) (G, 27), to section 1B of DIAL LIGHT (OFF-ON)-RING switch A/S-302, and to the mounting through terminal K of REC-TR CONTROL receptacle (A/J-312) (G, 27). Wiring within the mounting distributes the lead from A/J-312K to each of the control positions, H/E-6(1) for Control Box C-375/VRC, and H/J-1C for Control C-435/GRC (not used in these radio sets) or Control Group AN/GRA-6. Switch A/S-302 in the RING position completes the ground circuit for the control relays and the input circuit from 1,600-cycle ringing oscillator (par. 81).
- (2) *Interphone amplifier.* The control relay (D/O-1) within the interphone amplifier is supplied with energizing potential from the interphone amplifier plug-in power supply (par. 71). The battery supply voltage is connect-

ed through voltage-dropping resistors D/R-28 and D/R-27 to the coil of relay D/O-1 (H, 31). When a 12-volt battery supply is used; POWER SUPPLY PP-281/GRC is used with the amplifier and D/R-28 is bypassed. This allows the same voltage to be applied to the coil of relay D/O-1 from a 12-volt supply as from a 24-volt supply. The ground return from the coil of D/O-1 is completed through the contacts of RADIO-INT switch Y/S-1 (J, 31), and through the contacts of the push-to-talk switch, Y/S-2 (when this switch is pressed).

## 76. Microphone Circuits (fig. 94)

*a. Receiver-Transmitter.* The microphone circuit of the receiver-transmitter parallels the transmitter filament circuits. Energizing potential is not applied to this circuit until the transmit-control relays have operated (fig. 37). The circuit from the input transformer of the receiver-transmitter (H, 22) is completed to ground through the ON or OFF position of switch A/S-302, the Set 1 (counterclockwise) position of selector switch R/S-1, the RADIO TRANS. position of RADIO TRANS. switch R/S-2, the RADIO (operated) position of RADIO-INT switch Y/S-1, and push-to-talk switch Y/S-2 on the chest set. The microphone circuit also may be completed by the push-to-talk switch on a handset or chest set plugged into either of the AUDIO receptacles on the panel of the receiver-transmitter. When DIAL LIGHT (OFF-ON)-RING switch A/S-302 is at RING, the microphone circuit is opened by section 1D of this switch and a signal from the ringing oscillator (A/V-104B) is applied to the input transformer through section 1E of this switch.

*b. Interphone Amplifier.* The microphone circuit of the interphone amplifier parallels amplifier control relay D/O-1. When relay D/O-1 is energized, contacts 2 and 3 of this relay close to complete the ground side of the interphone amplifier input transformer through one of several alternate paths. Starting from contact 3 of D/O-1 ((H, 28) on fig. 94), the path to ground may be through the INT (unoperated) position of RADIO-INT switch Y/S-1 and the

push-to-talk switch (Y/S-2) of the chest set. This path is the most convenient one since only the push-to-talk switch on the chest set need be pressed to complete the interphone microphone circuit. Alternate paths are through terminal D/J-1C (amplifier panel AUDIO receptacle) and the push-to-talk switch of the audio accessory connected to that receptacle; through the Set 1 position of selector switch R/S-1, the RADIO TRANS. position of RADIO TRANS. switch R/S-2, the RADIO (operated) position of RADIO-INT switch Y/S-1, and the push-to-talk switch (Y/S-2) of the chest set; and through the center position of RADIO TRANS. switch R/S-2, the RADIO (operated) position of RADIO-INT switch Y/S-1, and the push-to-talk switch (Y/S-2) of the chest set.

## 77. Control Unit Circuits

In the following discussion the paths through the control positions mentioned in paragraph 75 are described. The circuits within Control Box C-375/VRC and Control Group AN/GRA-6 are shown on figures 94 and 95, respectively.

*a. Receiver-Transmitter and Interphone Amplifier Panels.*

- (1) If a handset or other audio device is connected to the panel-mounted AUDIO receptacles on the receiver-transmitter or the interphone amplifier, push-to-talk control of the unit is possible. Only that particular unit to which the audio device is connected may be controlled and monitored (par. 74) at the panel. The remaining control positions of the system have their customary control and monitoring facilities.
- (2) Pressing the push-to-talk switch of the connected audio device completes the ground lines of the microphone and relay circuits. The circuits through the audio devices are shown on figure 80.

*b. Control Box C-375/VRC.* Selector switch R/S-1 (I, 25), RADIO TRANS. switch R/S-2, and RADIO-INT switch Y/S-1 determine whether the receiver-transmitter transmit-control circuits will be energized or whether the circuits of the interphone amplifier alone will



operate. Pressing the push-to-talk switch completes the ground return for the control circuits set up by the above switches. The various circuit paths are described in (1) and (2) below.

(1) *Interphone paths* (fig. 94). The ground return line for the interphone amplifier microphone and relay circuits may be completed through the control box switches or independently of them. With the RADIO-INT switch Y/S-1 on the chest set in the INT position (J, 27 and J, 31) the circuits from the microphone input transformer D/T-1 (G, 28) and relay D/O-1 (H, 31) do not pass through either of the control box switches. If an audio device other than the chest set is in use these paths are not available. With the RADIO-INT switch in the RADIO position or some other audio device in use, the interphone amplifier microphone and control lines may be completed through the control box switches as follows: through sections 1A and 1B, respectively, of switch R/S-2 in the INT position or through sections 1A and 1B of R/S-2 in either RADIO TRANS. position and sections 1A front and 1C rear of selector switch R/S-1 in the INT position.

(2) *Receiver-transmitter* (fig. 94). The ground return lines for the receiver-transmitter microphone and relay circuits within the control box pass through terminals R/E-2(5), (I, 24) and R/E-2(1), (H, 29), respectively, the Set 1 position of selector switch R/S-1, one of the RADIO TRANS. positions of switch R/S-2, the RADIO position of Y/S-1, and the push-to-talk contacts.

c. *Control Group AN/GRA-6* (fig. 95). Though Local Control C-434/GRC of Control Group AN/GRA-6 (auxiliary equipment) normally is inserted in the mounting, the control group may be connected to the system through the receiver-transmitter or through the interphone amplifier and the receiver-transmitter. The various connections result in different push-to-talk facilities being available in each instance. However, the paths through the control group and the functions of the switches

within it remain the same for all connections, except that remote power control (ON-OFF) is possible only when the local control is plugged directly into the mounting.

(1) Completion of the ground return lines of the control circuits of the receiver-transmitter can be controlled from either the local or remote units. Two switches in the local unit and one in the remote unit help provide control when the push-to-talk switch is pressed. (In radio sets where push-to-talk control of two receiver-transmitters by the remote operator is desired, Radio Sets AN/GRC-3, -5, and -7, the REMOTE switch N/S-2 in the local unit must be placed in the SET 1 & 2 position. When REMOTE switch N/S-2 is in either the SET 1 or SET 2 position, the remote operator has control over the designated set only). When used with Radio Sets AN/VRC-20, -21, and -22, the REMOTE switch of the local control unit is set at SET 1 (or SET 1 & 2).

(2) Control of the ground return circuits from the remote unit is accomplished by means of two relays within the local unit (fig. 95). One of these relays (N/O-2) (I, 27) is polarized and contains a magnetic locking mechanism which holds the contacts of the switch in the position in which they appear until the proper potential is applied to make the contacts operate and lock in their other position. The polarity of the voltage applied to the relay is determined by SELECTOR switch M/S-2 in the remote unit. The other relay (N/O-1) (J, 28) is energized whenever current flows through it in either direction. A second polarized relay (N/O-3) (J, 28) in the local unit is a part of the remote power control system. This relay is discussed in paragraph 82.

(3) For push-to-talk operation from the local unit, LOCAL switch N/S-3 (J, 24, 25, 26) must be held in the SET 1 position. The switch, which is spring-loaded, returns to the TEL (center) position to complete the in-



terphone and receiver output circuits when the transmitter is not in use. The circuit from the mounting to ground for the relay circuits of Set 1 is completed through either section 1B of LOCAL switch N/S-3 (SET 1 position) or contacts of relays N/O-2 (4 and 6) and N/O-1 (7 and 6). The circuit through the local unit consists of terminal N/J-2C and the SET 1 contacts of section 1B of LOCAL switch N/S-3.

- (4) For push-to-talk operation from the remote unit, the circuit is completed through terminals C or N of N/J-2 as before, contacts 4 and 6 of relay N/O-2 (I, 26) and normally open contacts 7 and 6 of relay N/O-1 (J, 26). With the remote unit in control of operation, the microphone circuit is completed from the mounting to the audio device through terminal N/J-2T (I, 23), section 2E rear of REMOTE switch N/S-2 (I, 24), capacitor N/C-2B, contacts 5 and 8 of relay N/O-1 (J, 24), and the primary of transformer N/T-1 (J, 31). Capacitor N/C-2B (J, 23) decouples the ground for direct current, preventing the shorting of the filament supply. When LOCAL switch N/S-3 is in control, lines from terminal N/J-2T to the SET 1 position section 1C of N/S-3 shunt REMOTE switch N/S-2. The moving contact of N/S-3 is connected through the microphone and push-to-talk switch to ground.

## 78. Relay Operation

Before the transmit-control relays in the system units can be operated from the control units, certain preliminary switching must be performed. The switching makes possible the completion of the ground return lines described in paragraph 77.

*a. Control Box C-375/VRC (fig. 94).* When it is desired to control transmission the receiver-transmitter from one of the control box stations, the following switching must be performed:

- (1) Selector switch R/S-1 on the control box must be placed in the Set 1

(right-hand) position.

- (2) RADIO-TRANS. switch R/S-2 on the control box must be held or locked in one of the RADIO TRANS. positions.
- (3) RADIO-INT switch Y/S-1 on the chest set must be pressed. This switch is normally in the INT position.

*b. Local Control C-434/GRC (Auxiliary Equipment).*

- (1) When push-to-talk transmission is to be controlled from the local unit of Control Group AN/GRA-6, the following switching must be performed (fig. 95):
- (2) LOCAL switch N/S-3 must be held in the SET 1 position. The LOCAL switch is spring-loaded to return to the TEL (center) position.

*c. Remote Control C-433/GRC (Auxiliary Equipment).* When push-to-talk transmission is to be controlled from the remote unit of Control Group AN/GRA-6, the following switching must be performed:

- (1) REMOTE switch N/S-2 in the local unit must be placed in the SET 1 position.
- (2) SELECTOR switch M/S-2 in the remote unit must be placed in the left-hand write-in position.

## 79. Relay Functions (figs. 36 and 94)

When the preliminary switching on the control unit in use has been completed, pressing the push-to-talk switch completes the control relay ground return lines. The relays operate and perform the following switching functions.

*a. Relay A/O-301.* Contacts of relay A/O-301 switch the antenna from the auxiliary receiver and the receiver section of Set 1 to the transmitter section.

*b. Relay A/O-1.*

- (1) Contacts 2-3 (F, 32) of relay A/O-1 close to ground resistor A/R-109 and the control grid of audio amplifier A/V-115. This removes the negative bias that was applied to the audio amplifier and allows it to operate.
- (2) Contacts 6-7 (F, 43) of relay A/O-1 close to connect the plate voltage supply to A/V-9 and V-10. Contacts 4-5

(F, 46) close to apply voltage to the screen circuit of A/V-11.

*c. Relay A/O-101.*

- (1) Contacts 9-10 (G, 39) open and contacts 9-8 close to switch the 85-volt supply from receiver tubes A/V-1 and A/V-2 to transmitter tubes A/V-104A, A/V-105, A/V-106, and A/V-5 through A/V-8. If the DIAL LIGHT (OFF-ON)-RING switch is held in the RING position, voltage is made available to A/V-104B.
- (2) Contacts 2-3 (G, 23) of relay A/O-101 open and contacts 2-1 close to switch the a-f input of A/V-115 from the normal receive tap on the discriminator output voltage divider to the lower voltage tap used for side-tone during transmission.
- (3) Contacts 4-5 (G, 21) of relay A/O-101 close to complete the microphone circuit and the filament lead to transmitter tubes A/V-5 through A/V-11 and A/V-104 through A/V-106.
- (4) Contacts 6-7 (G, 19) of relay A/O-101 close to complete a circuit for the coil of relay E/O-1 in the power supply. Relay E/O-1 operates to complete the power-input circuits for the transmitter filaments and the transmitter h-v (high-voltage) supplies.

*d. Relay E/O-1.*

- (1) Contacts 2-3 (C, 20) of relay E/O-1 complete the battery circuit from

OPERATE switch E/S-1D to the filaments and filament protection circuit in the transmitter. In 24-volt systems, dropping resistor E/R-36 and ballast tubes E/R-37, -38, -24, and -25 are included in the input circuit. In 12-volt systems, E/R-36 and ballast tubes E/R-37 and -38 are omitted. The filament protection circuit utilizes thermal relay E/K-1 which, when operated, causes resistor E/R-26 to be inserted in series with the transmitter filaments. The filaments supplied are those described in paragraph 70c and shown on figure 37. Complete filament circuit details are shown on figure 83.

- (2) Contacts 4-5 (C, 35) of relay E/O-1 close to short circuit resistor E/R-21 in the 85-volt supply circuit. This operation compensates for the increased drain on the power supply during transmission.
- (3) Contacts 7-8 (C, 43) and 9-10 (C, 45) of relay E/O-1 complete the battery input circuit from sections 1B and 1A of the OPERATE switch (E/S-1) to the 150-volt vibrator power supply and 300-volt vibrator power supply, respectively.

*e. Relay D/O-1.* Contacts 2 and 3 (H, 28) close to complete the microphone control line. The ground line of the interphone amplifier input transformer is completed.

## Section IV. RINGING AND REMOTE POWER CONTROL CIRCUITS

### 80. General

The ringing circuits and the remote power-control circuits are discussed in this section. The receiver-transmitter contains one ringing circuit. Control Group AN/GRA-6 contains a second ringing circuit and a circuit which provides remote power control of the radio set.

### 81. Ringing Circuits

*a. System Circuit* (fig. 94). The system ringing circuit is contained within the receiver-transmitter. The output of this circuit is supplied to the transmitter and all monitoring stations in the system. Ringing oscillator A/V-

104B and DIAL LIGHT (OFF-ON)-RING switch A/S-302 are the signal source and switching components respectively. Switch A/S-302, when placed in the RING position, performs the following functions:

- (1) Section 1C rear (G, 42) completes the plate circuit for 1,600-cycle ringing oscillator A/V-104B.
- (2) Section 1D (H, 23) breaks the microphone circuit of Set 1.
- (3) Section 1B (G, 27) completes the ground-return line for the Set 1 transmit-control relay, allowing the carrier to be transmitted.
- (4) Section 1E (G, 23) completes the



ringing circuit from the oscillator output transformer A/T-105 to the Set 1 input transformer A/T-106. The 1,600-cycle ringing oscillator signal modulates the transmitter carrier signal.

- (5) Section 1A (H, 16) completes the circuit for the Set 1 dial light.

*b. Control Group AN/GRA-6 Ringing Circuit (fig. 95).*

- (1) The ringing circuit within the control group is completely independent of the remainder of the radio set. An operator at either one of the control group units can ring the other unit at any time when the units are connected by a telephone pair. Use of switch N/S-1 within the local unit and switch M/S-1 within the remote unit allow the selection of a glow lamp or a bell as the call indicator. The circuit arrangement within the two units is symmetrical.
- (2) When the operator at either the local or remote control unit cranks the panel-mounted, ringer generator crankshaft, a 20-cycle signal (generated by magneto-type generator G-1) (J, 35) is applied to the telephone line. When not operating, the generator is disconnected from the line by a set of contacts actuated by the crankshaft. The ringing signal enters the distant control unit through binding posts L1 and L2, windings 1-2 and 3-4 of transformer N/T-1, and contacts 3 and 2 of the unit generator. The ringing signal within the distant unit is applied across either the bell circuit or the glow lamp circuit, depending on the position of internal BELL-LAMP switch N/S-1.
- (3) Inductive coupling through the 3-4 windings and the 7-9 windings of the transformers in each unit makes it possible to hear the ringing signal in the headphones of both operators. Since the energizing circuit from the remote unit to the control relays in the local unit passes through the normally closed contacts of the generators, it is impossible to operate the

receiver-transmitters from the remote unit while the generator is being cranked. The generator contacts in the sending unit also disconnect the bell and glow lamp circuit within that unit, to prevent their being energized by the outgoing ringing signal.

## 82. Remote Power Control Circuits

*a. General.* One of the facilities provided by Control Group AN/GRA-6 is the extension of power control of the radio sets to a remote location. This is accomplished through the action of two relays, N/O-3 in Local Control C-434/GRC and H/K-1 in Mounting MT-297/-GR. Relay N/O-3, which is under the control of manually operated switches in Remote Control C-433/GRC, is used to control the completion of the ground-return line of relay H/K-1, which in turn controls the application of power to the system. This enables an operator at the remote unit to have power control of the radio set.

*b. Preliminary Switching (fig. 95).* The preliminary switching arrangement necessary for remote power control is described below:

- (1) OFF-REMOTE-ON switch H/S-1 (F, 2 and G, 1) on the mounting is in the REMOTE position.
- (2) LOCAL switch N/S-3, (J, 24; J, 25; and J, 26) on the local unit is in the TEL position.
- (3) REMOTE switch N/S-2 on the local unit (I, 24; I, 27; J, 27; and J, 30) is in the SET 1 position. (The SET 1 & 2 position of the switch do not permit remote power control. The SET 2 position is used only with radio sets, such as the AN/GRC-3 through -8 which contain two receiver-transmitters.)

*c. Circuit Arrangements (fig. 95).*

- (1) When the push-to-talk switch on the audio accessory attached to the remote control unit is pressed, a circuit is completed which applies the voltage of battery BT-3 (J, 39) across three series-connected relays, N/O-1, N/O-2, and N/O-3, in the local unit. This circuit extends from the positive terminal of battery BT-3 through the



left-hand write-in position of section 1A of SELECTOR switch M/S-2, through a pair of contacts of the push-to-talk switch, through the normally closed contacts of the ringing generator, through terminals 2 and 1 of transformer M/T-1, through binding post L1 of the remote control unit, through one lead of the telephone line to binding post L1 of the local control unit, through terminals 1 and 2 of transformer N/T-1, through the normally closed contacts of the ringing generator, through terminals 3 and 2 of relay N/O-1, through the SET 1 position of section 1A rear of REMOTE switch N/S-2, through terminals 2 and 3 of relay N/O-2, through the SET 1 position of section 1B rear of REMOTE switch N/S-2, through terminals 2 and 3 of relay N/O-3, through terminals 3 and 4 of transformer N/T-1, through binding post L2 of the local control unit, through one lead of the telephone line to binding post L2 of the remote control unit, through terminals 4 and 3 of transformer M/T-1, through the left-hand write-in position of section 1B of SELECTOR switch M/S-2, through resistor M/R-2, and back to the negative terminal of battery BT-3.

- (2) Relays N/O-2 and N/O-3 are polarized magnetically locking relays which transfer contacts only when a voltage of the proper polarity is applied to them. When these relays are in the position where contacts 4 and 6 are open and 6 and 7 are closed, an applied voltage having a polarity which makes terminal 2 positive with respect to terminal 3 (on each of these relay coils) transfers the contacts so that 4 and 6 close and 6 and 7 open. If a reverse polarity voltage then is applied to the relay coils, the contacts again transfer. If a voltage with the improper polarity is applied, these relays are not actuated. Also, when the applied voltage is removed, the contacts remain magnetically locked in

position. A reverse polarity voltage is always necessary to transfer them. A reverse polarity voltage is applied when SELECTOR switch M/S-2 on the remote control unit is set at the right-hand write-in position and the push-to-talk switch associated with that unit is pressed.

- (3) Relays N/O-1 and N/O-2 control push-to-talk and monitoring operations respectively (par. 77c). Relay N/O-3 controls the application of power to the entire radio set. When the power switch on the mounting is at REMOTE, the ground return for relay H/K-1 (F, 1) passes through normally open contacts 4 and 6 (I, 1) of relay N/O-3. When this relay is actuated by a voltage of the proper polarity (terminal 2 positive with respect to terminal 3), contacts 4 and 6 close, relay H/K-1 pulls in, and power is applied to the radio set.
- (4) When the push-to-talk switch on the audio accessory which is attached to the remote control is released, relay N/O-1 (which is neither polarized nor locking) releases. Contacts 7 and 6 (J, 26) open to break the ground return for the control relays in the receiver-transmitter, and contacts 5 and 8 open to break the microphone circuit. This restores the receiver-transmitter to the receive condition. Relays N/O-2 and N/O-3, however, remain locked in position, thus maintaining the monitoring and the main power supply circuits respectively.
- (5) When SELECTOR switch M/S-2 on the remote control unit is set at the right-hand write-in position and the push-to-talk switch on the audio accessory at this unit is pressed, a reverse polarity voltage is applied to relays N/O-1, N/O-2, and N/O-3. This transfers the contacts of N/O-2 and N/O-3 and thus breaks the monitoring and main power circuits of the radio set. Although N/O-1 pulls in when this occurs, it serves no purpose since all power has been cut off in the radio set. Release of the push-to-talk

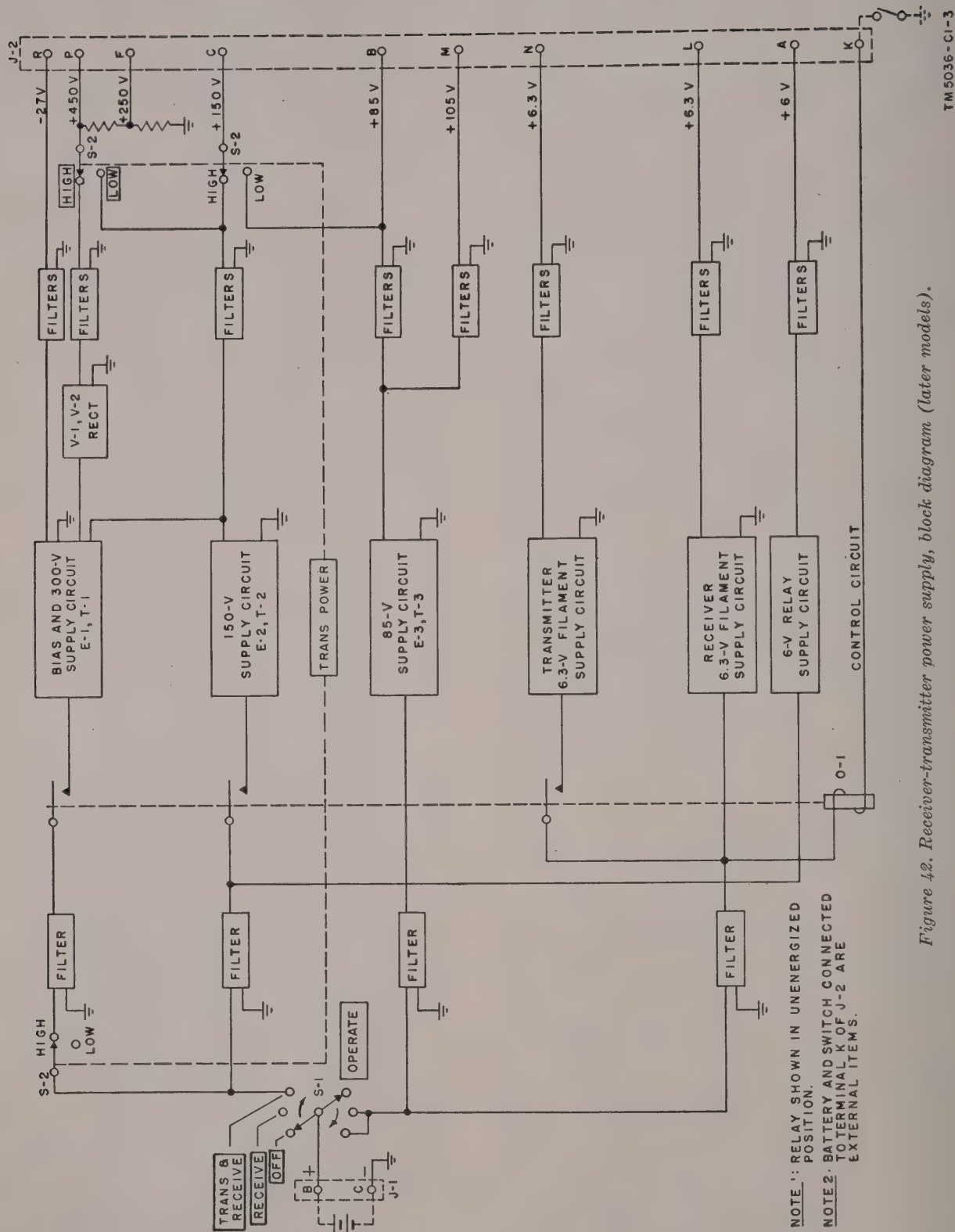


Figure 42. Receiver-transmitter power supply, block diagram (later models).

button restores N/O-1 to its normal position and produces no effect on relays N/O-2 and N/O-3. The set is now turned off. Relays N/O-2 and N/O-3 are in such a position that

power again can be applied to the radio set when SELECTOR switch M/S-2 is set at the left-hand write-in position and the push-to-talk switch at the remote control unit is pressed.

## Section V. UNIT THEORY

### 83. General

The discussion of unit theory is limited to block diagram analyses of the major units. Although the maintenance information included in this manual is at an organizational level only, familiarity with the block diagrams of the units will be helpful in trouble shooting. A knowledge of which tubes are receiving tubes and which tubes are transmitting tubes, for example, will aid in the replacement of parts for which the operator has running spares. The block diagrams are shown in figures 42 through 45. Complete schematic diagrams for all units are included as additional information for maintenance personnel (figs. 73 through 93). Resistor and capacitor color and letter codes also are included (figs. 98 and 99).

### 84. Receiver-Transmitter Power Supply (fig. 42)

a. Figure 42 is a functional block diagram of Power Supply PP-109/GR or Power Supply PP-112/GRC. It shows the three h-v circuits and the three l-v circuits supplied from the storage battery input terminals. The h-v circuits are used to provide the plate, screen, and bias voltages for the receiver and transmitter circuits in Receiver-Transmitter RT-66/GRC, RT-67/GRC, or RT-68/GRC. The l-v circuits supply the receiver-transmitter filament and relay potentials.

b. The 85-volt circuit (E-3 and T-3) is energized whenever OPERATE switch S-1 is in the RECEIVE or TRANS & RECEIVE position. The other two h-v circuits, E-2 and T-2, E-1 and T-1, and the transmitter filament supply circuit, are energized when switch S-1 is in the TRANS & RECEIVE position and relay O-1 is energized. E-1 and T-1 are controlled also by TRANS POWER switch S-2, which must be in the HIGH position for E-1 and T-1 to operate.

c. The l-v circuits include the receiver filament supply circuit with output at terminal L of J-2, the transmitter filament supply circuit with output at terminal N of J-2, and the relay supply circuit with output at terminal A of J-2. On later models of the power supply, the 6-volt relay supply circuit is completed only when S-1 is in the TRANS & RECEIVE position (fig. 42).

d. The h-v and l-v circuits are equipped with r-f noise suppression filters in both the input and output leads, and a-c ripple filters in the output leads.

e. TRANS POWER switch S-2 consists of two sections, both of which are used in the h-v circuit. One section of S-2 is used to provide full or reduced voltages as required for HIGH or LOW power operation, respectively. The other section of S-2 opens the input to the transmitter h-v and bias supply circuit when the TRANS POWER switch is in the LOW position.

### 85. Receiver-Transmitter Transmitting Circuits (fig. 43)

The block diagram shown in figure 43 pertains equally to Receiver-Transmitter RT-66/-GRC, RT-67/GRC, and RT-68/GRC. The transmitter circuits include a microphone input transformer, a reactance modulator (V-105 and V-106), a transmitter oscillator (V-104A), the common crystal oscillator-harmonic generator (V-3 and V-4), the transmitter harmonic amplifier (V-5), a mixer (V-6), an r-f amplifier (V-7 and V-8 in parallel), a driver (V-9 and V-10 in parallel), the power amplifier (V-11), the transmitter antenna circuit, and the common receiver-transmitter antenna.

a. *Transmitter Signal Path.* Voice signals from an external source are applied through a signal input switch (DIAL LIGHT OFF-ON-RING), microphone transformer to the input



Figure 43. Receiver-transmitter, block diagram.

of the transmitter reactance modulator. Under control of the audio signals, the reactance modulator causes the frequency generated by section A of transmitter-oscillator V-104 to vary up or down in accordance with the amplitude and frequency of audio signals. Modulation is represented by a shift in the frequency generated by the transmitter oscillator, and, ultimately, by a corresponding shift of the overall carrier frequency. The output of transmitter-oscillator V-104A and the output of harmonic amplifier V-5 are combined in transmitter mixer stage V-6. A tuned circuit, using a section of tuning capacitor C-1, selects the desired sum frequency at the output of the transmitter mixer and applies it to transmitter r-f amplifier stage V-7 and V-8. The output of this stage is tuned to resonance at the carrier frequency by capacitor C-1. Further amplification is provided by transmitter driver stages V-9 and V-10, using a section of r-f tuning capacitor C-1, and by transmitter power amplifier stage V-11. The amplified output is then routed through a tuned circuit to the antenna. The output circuit of the power amplifier uses a section of main tuning capacitor C-1. This output is applied through a tuned antenna circuit (not shown on the block diagram) and through a pair of contacts of the antenna switching relay to the antenna.

*b. Automatic Frequency Control.* The afc (automatic frequency control) circuit maintains a constant transmitter-oscillator carrier frequency. The output of transmitter-oscillator V-104A is picked up by the variable i-f stages in the receiver through stray coupling and fed to the remainder of the receiver circuit. If the difference between the receiver-oscillator frequency (used as the standard) and the transmitter-oscillator frequency varies from the fixed i-f frequency, a voltage is developed in the discriminator circuit. This voltage is used as the afc voltage and is fed to transmitter reactance tubes V-105 and V-106. The transmitter reactance stage then corrects the transmitter-oscillator frequency. The time constant of the afc coupling circuit from the discriminator is such that normal modulation of the i-f does not appear in the afc voltage.

*c. Sidetone.* Sidetone voltage is obtained from transmitter-oscillator V-104A. This voltage is picked up by the variable i-f stages

through stray coupling and is fed through the remainder of the receiver circuit to the AUDIO output connector and fixed-level audio output terminals.

*d. Ringer Circuit.* A ringer circuit associated with the transmitter is energized when the DIAL LIGHT OFF-ON-RING switch is in the RING position. This switch has the same function for the ringing circuit that the push-to-talk button of the microphone has for the transmitter, since it causes the control relays to be energized when it is in the RING position. In addition, it applies power to the 1,600-cycle ringer oscillator, section B of tube V-104. The output of the ringer oscillator is applied to the microphone transformer. Signal transmission is accomplished as described in *a* above for any audio signal.

## 86. Receiver-Transmitter Receiving Circuits (fig. 43)

The receiver is of the double-conversion superheterodyne type arranged to receive f-m signals. The term *double conversion* means that the incoming carrier signal beats with one local oscillator frequency to produce a first intermediate frequency (between 4.45 and 5.45 mc); this frequency, in turn, beats with another oscillator frequency to produce a second intermediate frequency (in this case 1.4 mc). The discriminator demodulates the second i-f signal and the a-f section of the receiver amplifies the audio output of the discriminator. The amplified output is supplied to headphones, loudspeaker, retransmission circuits, and to monitoring circuits (fig. 96).

*a. Input Circuit.* When the control relays are in the normal (unenergized) position, the antenna is connected to the receiver circuits. Signals from the antenna are passed through the antenna circuit which is tuned by a section of receiver-transmitter r-f tuning capacitor C-1. The signals selected are applied to r-f amplifier stage V-1, the output of which is tuned by a section of receiver-transmitter r-f tuning capacitor C-1. The amplified output of this stage is routed to the receiver first mixer stage. When the SQUELCH control is turned clockwise from the OFF position, the gain of the r-f amplifier stage is controlled by the squelch circuit. (In some of the later models, the gain of the r-f amplifier is controlled by the

grid leak bias voltage developed at the grid of the first limiter (VIII).)

*b. First Mixer Stage V-2.* This stage combines the output of harmonic amplifier V-4 with the amplified output of the r-f amplifier stage, V-1, to produce the first intermediate frequency in the range of 4.45 to 5.45 mc. The frequency produced depends on the setting of the TENTH MCS control. The crystal oscillator-harmonic generator and first harmonic amplifier serve both the transmitter and the receiver. Since the output frequency of the first harmonic amplifier is below the frequency to which the receiver-transmitter is tuned (between 4.45 and 5.45 mc, depending on the setting of the tuning controls), the first i-f band resulting from the mixing of the incoming signal with the output of the frequency harmonic amplifier is a band centered about the difference frequency. The plate circuit of mixer stage V-2, located on the r-f chassis, is tuned by a section of variable i-f tuning capacitor C-101.

*c. Amplification of First I-F Signal.* The difference frequency band at the output of mixer stage V-2 is amplified in a two-stage, tuned, variable i-f amplifier, V-107 and V-108. The variable i-f amplifier stages are tuned by sections of variable tuning capacitor C-101.

*d. Receiver-Oscillator V-101.* Free-running, self-excited oscillator V-101 generates a frequency between 3.05 and 4.05 mc, depending on the setting of a section of variable i-f tuning capacitor C-101. The frequency to which the oscillator is tuned is always 1.4 mc below the frequency to which the variable i-f amplifier is tuned. Thus, if the variable i-f amplifier is tuned to 5 mc, the receiver-oscillator is tuned to 5 minus 1.4 or 3.6 mc.

*e. Receiver Second Mixer V-109.* The output of the variable i-f amplifier (a frequency between 4.45 and 5.45 mc), together with the output of receiver-oscillator V-101 is combined in second receiver mixer V-109. The frequency generated by the oscillator subtracts from the first (variable) i-f signals to produce a second intermediate frequency of 1.4 mc.

*f. Fixed Second I-F Amplifier and Limiter.*

The intermediate frequency of 1.4 mc is again amplified by a three-stage, fixed-tuned amplifier. The first stage, V-110, is a conventional i-f amplifier. The second and third stages, V-111 and V-112, also are designed to

function as limiters to eliminate any amplitude variations of the signal. Such amplitude variations represent noise and are undesirable. Proper functioning of the discriminator, which follows the second limiter, requires that the level of the signal applied to it be fairly uniform despite variations in the level of the incoming signal. A portion of the grid-bias voltage of the first limiter is applied to the grid of the squelch oscillator to disable this oscillator when a signal of sufficient strength is received (*i* below).

*g. Discriminator.* The output of the final limiter stage, V-112, is applied to the discriminator, V-113 and V-114. The discriminator performs a function analogous to that of the a-m detector by converting the variations from the center frequency of the incoming signal into audio signals.

*h. Audio Amplification.* The a-f signals which appear at the output of the discriminator are amplified in two separate audio amplifier circuits.

- (1) One circuit is a two-stage audio amplifier, V-115 and V-116, with gain adjusted by the panel-mounted VOLUME control. The output of the first stage, V-115, is connected to pins A of each of the AUDIO connectors and provides enough volume to operate a headphone or the earpiece of a handset. The output of final audio power amplifier stage V-116 is connected to pins L of each of the AUDIO connectors and has sufficient output to drive a loudspeaker.
- (2) The other circuit, a one-stage amplifier V-102, provides an audio output signal for monitoring (fig. 96). No panel adjustment of volume is provided. The output of this stage is connected to pin B of the REC-TR CONTROL connector (J-312, fig. 96).

*i. Squelch Oscillator V-103.* In the absence of signals, a rushing noise is heard in the receiver phones or loudspeaker of sensitive receivers. The noise is the result of external electrical disturbances and thermal agitation in the vacuum tubes and receiver components. A squelch circuit is used to suppress this noise by biasing off the first audio, V-115, and the retransmit audio, V-102, during no-signal in-



tervals. In the receiver-transmitter, the squelch circuit consists of a 20-kc (approximately) oscillator and a diode rectifier, V-103. The squelch oscillator operates only when very weak signals or no signals are applied to the receiver r-f amplifier. Squelch action is adjusted by the panel-mounted SQUELCH control. The squelch circuit can be disabled for test purposes or for reception of very weak or fading signals by turning the SQUELCH control to the OFF position.

## 87. Interphone Amplifier (fig. 44)

Figure 44 is a functional block diagram of AF Amplifier AM-65/GRC. The diagram shows the signal and power supply circuits which are provided by the amplifier. The signal circuits consist of three input channels, a common amplifier, and three amplifying paths. The input circuits of the Set 1 and Set 2 channels are arranged to accept signals from the output of the Set 1 and Set 2 receivers, and the input circuit of the interphone channel will accept signals from a microphone. Microphones at Control Box C-375/VRC, at Control C-435/GRC (not used with Radio Sets AN/VRC-20, -21, and -22), and at the panel of the amplifier may be switched into the interphone channel. (Set 2 is not a part of Radio Sets AN/VRC-20, -21, and -22.)

*a. Common Channel Amplifier.* Signals from the receiver-transmitter and auxiliary receiver are routed to the common channel amplifier, amplified, and appear in the output circuits of that stage. When an operator presses the push-to-talk button on an interphone-connected microphone, relay O-1 is energized. Contacts of the relay close to complete the circuit to the external microphone and apply energizing potential to the microphone from the internal power supply circuits. Speech signals from the microphone enter the amplifier through the closed contacts of relay O-1, are amplified by V-1, and appear in the output circuits of that stage. An audio-mixing arrangement in the common amplifier stage distributes the signals appearing at its output to the three output channels, as described in *b* below.

*b. Signal Distribution.* The Set 1 and interphone signals are applied at the required levels

to Set 1 + interphone and Set 1 + Set 2 + interphone channels. In a similar manner, Set 2 (not included in Radio Sets AN/VRC-20, -21, and -22) and interphone signals are applied at the proper levels to the Set 2 + interphone and the Set 1 + Set 2 + interphone channels. Signals from Set 1 do not enter the Set 2 + interphone channel nor do signals from Set 2 enter the Set 1 + interphone channel. The Set 1 + Set 2 + interphone channel carries signals from all three sources.

*c. Output Circuits.* Signals passing through the Set 1 + interphone channel are amplified in amplifier V-2 and appear at the output terminal for that channel. Similarly, signals passing through the Set 2 + interphone channel are amplified in output amplifier V-3 and appear at the output terminals for that stage. Signals passing through the Set 1 + Set 2 + interphone channel are amplified by driver amplifier V-4 and output amplifier V-5 and are applied through a VOLUME control to a 600-ohm output connector for application to Control C-435/GRC or Local Control C-434/GRC and to AUDIO connector J-1 (fig. 95). These signals also are applied to a 150-ohm output connection for application to Control Box C-375/VRC (fig. 95).

*d. Power Supply Circuits.* The battery input is connected through panel-mounted connector J-6, through a fuse, and through contacts of panel-mounted OFF-INT-RT-70 switch S-2 to a h-v and l-v supply circuit. The switch serves as the power on-off switch for the amplifier and for Receiver-Transmitter RT-70/GRC (not included in Radio Sets AN/VRC-20, -21, and -22). The h-v supply circuit includes a plug-in vibrator type power supply unit which converts the battery voltage into the required plate and screen voltages for the amplifier (and for Receiver-Transmitter RT-70/GRC in radio sets in which a Set 2 is used). The plate and screen voltages for the amplifier are taken directly from the output of the power supply unit. The voltages for Receiver-Transmitter RT-70/GRC are routed through the contacts of switch S-2 and through a voltage regulator circuit to terminals of panel-mounted connectors. The l-v supply circuit provides the filament, relay, microphone, and bias voltages for the amplifier. The control and filament voltages for Receiver-Transmitter RT-70/GRC are

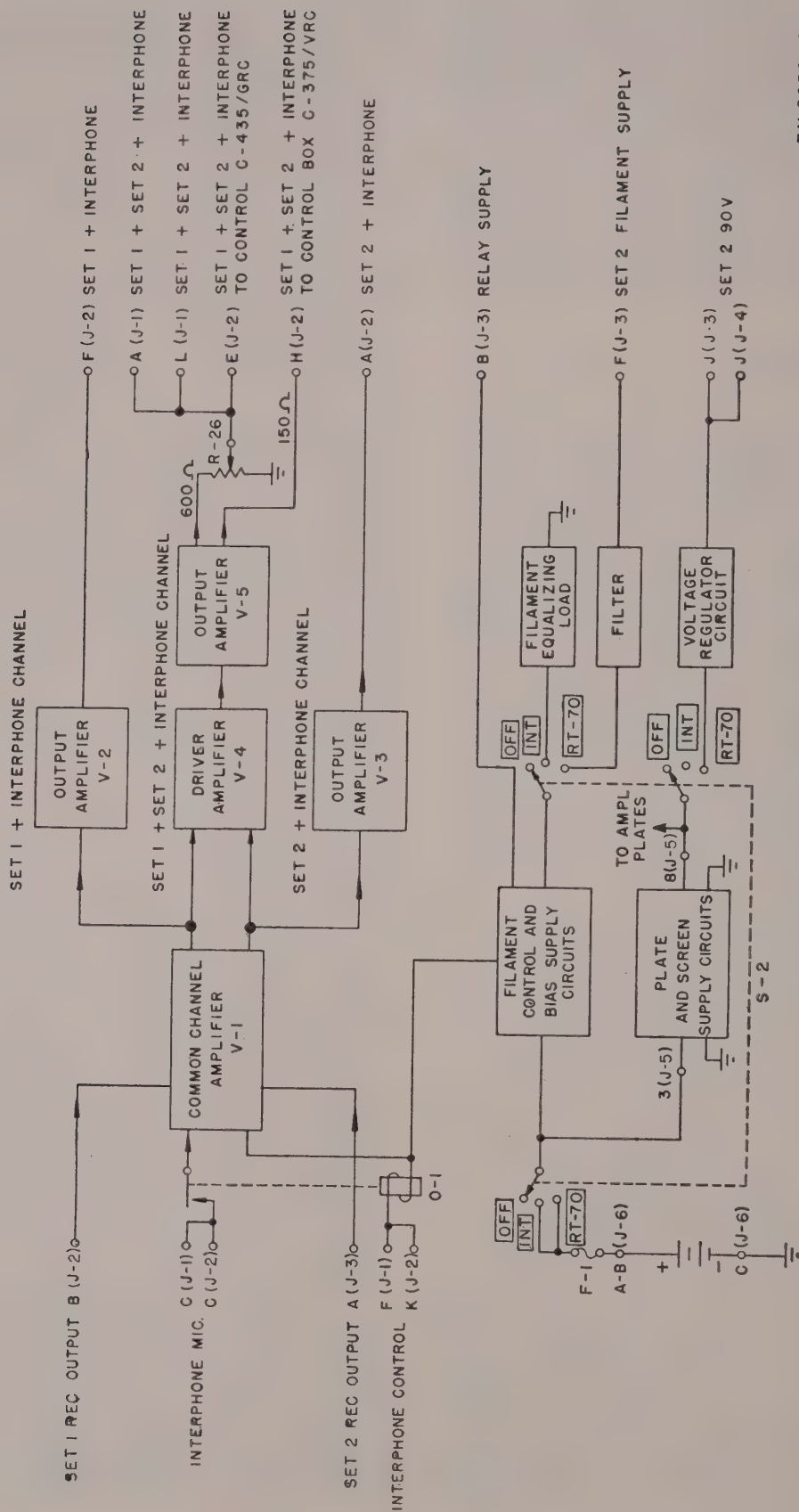


Figure 44. Interphone amplifier, block diagram.

supplied to panel-mounted connector J-3. The filament supply circuit includes contacts of an a-f filter and switch S-2, in the RT-70 position. When Receiver-Transmitter RT-70/GRC is not used, a filament equalizing load is substituted across the filament supply circuit by placing switch S-2 in the INT position. This keeps the voltage applied to the filaments of the interphone amplifier constant by maintaining a constant load on the filament supply. Otherwise, the voltage applied to the filament of the interphone amplifier tubes would rise with a resulting decrease in the life of these tubes.

## 88. Auxiliary Receiver (fig. 45)

The block diagram is equally representative of Radio Receivers R-108/GRC, R-109/GRC, and R-110/GRC which are used in Radio Sets AN/VRC-20, -21, and -22 respectively. Each receiver is of the single-conversion, superheterodyne type, designed to receive f-m signals. Differences in the receivers lie in the frequency range covered by each, as indicated in the frequency spectrum chart (fig. 2).

*a. Input Circuit.* Carrier signals from the antenna are applied to r-f amplifier stage V-1. The amplified output of this stage is routed to mixer stage V-2. When the SQUELCH control is turned clockwise from the OFF position, the gain of the r-f amplifier is controlled by the squelch circuit. In some of the later models, the gain of the r-f amplifier is controlled by a feedback voltage from the limiter grid.

*b. Mixer Stage V-2 and Oscillator V-3.* The mixer stage combines the output of local oscillator V-3 with the amplified output of the r-f amplifier stage to produce an intermediate frequency of 4.3 mc. The grid circuit of the mixer stage V-2 is tuned by section D of tuning capacitor C-3. The oscillator stage is tuned by section F of tuning capacitor C-3.

*c. I-F Amplifier and Limiter Stages.* The i-f signal is amplified by a four-stage, fixed-tuned amplifier. The first two stages, V-4 and V-5, are conventional i-f amplifiers; the third and fourth stages, V-6 and V-7, also are designed to function as limiters to eliminate any amplitude variations of the signal. They act mainly to limit the variations of the very strong signals. The limiter stage (V-8) also provides limiting action on weak signals.

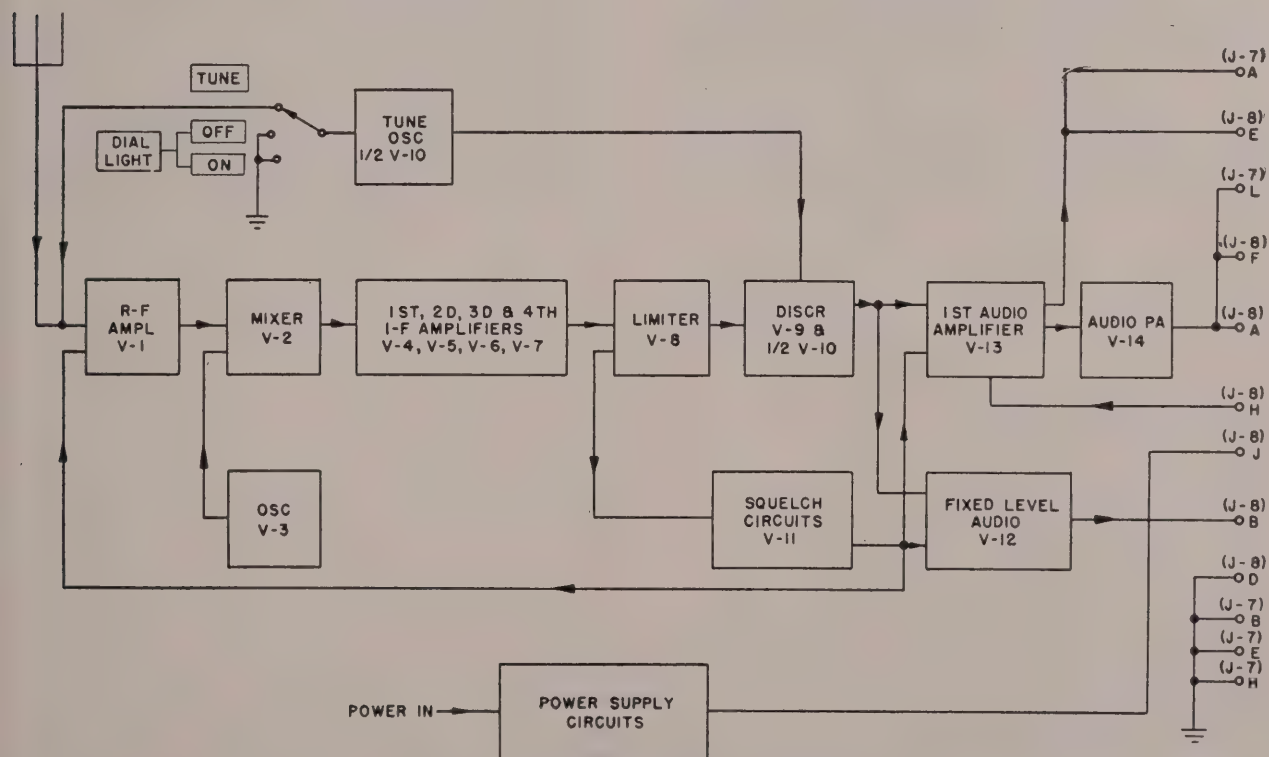


Figure 45. Auxiliary receiver, block diagram.

TM 898-10



*d. Discriminator.* The output of the final limiter stage, V-8, is applied to the discriminator and squelch circuits. The discriminator performs a function analogous to that of the a-m detector, since it extracts the intelligence or audio modulation from the incoming carrier signal. The discriminator converts the variation in frequency (the intelligence) of the incoming signals into audio signals.

*e. Audio Amplification.* The a-f signals that appear at the output of the discriminator are amplified in two separate audio amplifier circuits.

- (1) One circuit is a two-stage audio amplifier, V-13 and V-14, with gain adjusted by the panel-mounted VOLUME control. The output of the first stage, V-13, is connected to pins J-7A (AUDIO) and J-8E (REC CONTROL) and is used to provide enough volume to operate a headphone or the earpiece of a handset. The output of the final audio power amplifier stage, V-14, is connected to pin J-7L (AUDIO) and pins J-8A and J-8F (REC CONTROL) for connection to a loudspeaker. The REC CONTROL receptacle is connected by a cable to the mounting and from the mounting by another cable to one or more control boxes on which AUDIO connectors are located for accommodating chest sets, handsets, or loudspeakers.

- (2) The other amplifier circuit, a one-stage amplifier, V-12, serves to provide a fixed level audio output signal for monitoring (fig. 96). No panel adjustment of volume is provided. The output of this stage is connected to pin J-8B (REC CONTROL).

*f. Squelch Circuits (V-11).* A squelch circuit is used to suppress the noise that is heard during no-signal intervals. This noise is a result of external electrical disturbances and thermal agitation in the vacuum tubes and receiver components. Squelch action is adjusted by the panel-mounted SQUELCH control. The squelch circuit can be disabled for test purposes or for reception of very weak or fading signals by turning the SQUELCH control to the OFF position.

*g. Tuning Oscillator V-10.* The pentode section of this tube is used as a crystal-controlled oscillator for calibration purposes. The fundamental frequency (4.3 mc) is coupled within the tube to the discriminator circuit, since the dual-purpose 1S5 tube is used as a discriminator and a tuning oscillator. Harmonics of the crystal oscillator are fed to the r-f amplifier, which is tuned to a frequency which is a multiple of 4.3 mc. If a zero beat is obtained, the dial is correct, otherwise the dial must be adjusted mechanically.

*h. Power Supply.* For vehicular operation, the power is obtained from the battery of the vehicle and vibrator power supply. The input to the vibrator power supply is 12 or 24 volts.

# CHAPTER 5

## ORGANIZATIONAL MAINTENANCE

### Section I. PREVENTIVE MAINTENANCE

#### 89. Definition

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5.

#### 90. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent, dry-cleaning (SD) and wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride and wipe them dry with a dry cloth.

**Caution:** Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 pounds per square inch to remove dust from inaccessible places. Be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

#### 91. Use of Preventive Maintenance Forms

a. The information in paragraph 92 is presented as a guide to the individual making an inspection of equipment in accordance with instructions on DA AGO Forms 11-238 and 11-239. The decision as to which items on the

forms are applicable to this equipment is a tactical decision to be made in the case of First Echelon Maintenance by the Communication Officer/Chief or his designated representative, and in the case of Second or Third Echelon Maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. The first two columns in the table in paragraph 92 serve as a cross reference between the item numbers of DA AGO Forms 11-238 and 11-239 which are partially or totally applicable to Radio Sets AN/VRC-20, -21, and -22, and the preventive maintenance information in this manual.

#### 92. Performing Preventive Maintenance

The following preventive maintenance operations should be performed at the intervals indicated, unless these intervals are reduced by the local commander.

**Caution:** Screws, bolts and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

DA AGO Form 11-238 item No.	DA AGO Form 11-239 item, No.	Preventive maintenance operations
		<i>Daily</i>
1	1	Check for completeness and satisfactory condition of the radio set. The components of the radio set are listed in the table of paragraph 6 and are illustrated in figure 27.
2	2	Check suitability of location and installation for normal operation.
3	3	Clean dirt and moisture from antenna, microphone, headsets, chest sets, jacks, plugs, carrying bags, and panels of the component parts.

DA AGO Form 11-238 item No.	DA AGO Form 11-239 item No.	Preventive maintenance operations	DA AGO Form 11-238 item No.	DA AGO Form 11-239 item No.	Preventive maintenance operations
4	4	Inspect the seating of the plug-in vibrator power supplies located in the auxiliary receiver and in the interphone amplifier; inspect the seating of the vibrator units located in these power supplies and also in the receiver-transmitter power supply (PP-109/GR or PP-112/GR); inspect the seating of all fuses mounted on the panels of the interphone amplifier, the receiver-transmitter power supply, and the auxiliary receiver; inspect the seating of all plugs and connectors on the radio set.	15	15	dows of the receiver-transmitter and the dial window on the auxiliary receiver.
5	5	Inspect all controls for binding, scraping, excessive looseness, worn or chipped gears, misalignment, and positive action.	16	16	Inspect the meter on the receiver-transmitter for damaged glass and case.
6	6	Check radio set for normal operation (par. 94). <i>Weekly</i> <b>Caution:</b> Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.	18	18	Inspect shelters and covers for adequacy of weatherproofing.
7	7	Clean and tighten the panel mountings on all components of the radio set (fig. 3).		19	Check interphone box and junction boxes of mounting for cracks, leaks, dirt, and grease.
8	8	Inspect cases, mounting, antenna, and exposed metal surfaces for rust, corrosion, and moisture.		21	<i>Monthly</i> Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket spring tension; clean dust and dirt carefully; check emission of receiver type tubes.
9	9	Inspect cords, cables, wires and shock mounts for cuts, breaks, fraying, deterioration, kinks, and strain.		22	Inspect fixed capacitors for leaks, bulges, and discoloration.
10	10	Inspect antenna for eccentricities, corrosion, loose fit, and damaged insulators (fig. 1).		23	Inspect all relays located in the receiver-transmitter, the receiver-transmitter power supply, and the mounting for loose mountings, burned, pitted, and corroded contacts, misalignment of contacts and springs, insufficient spring tension, or binding of armatures or any moving parts.
11	11	Inspect Bag CW-206/GR, the straps of Chest Set Group AN/GSA-6, and technical manuals TM 11-642 for tears, mildew, or fraying.		24	Check the following variable capacitors for dirt, moisture, misalignment of plates, and loose mounting: C-1, C-17, and C-101 in the receiver-transmitter; C-3 in the auxiliary receiver.
13	13	Inspect storage batteries for dirt, loose terminals, electrolyte level, specific gravity, and damaged cases.		25	Inspect resistors, bushings, and insulators for cracks, chippings, blistering, discoloration, and moisture.
14	14	Clean nameplates on all components of the radio set; clean the dial and meter win-		26	Inspect terminals of all large fixed capacitors and resistors for corrosion, dirt, and loose contacts.
				27	Clean and tighten switches, relay cases, and interiors of chassis and cases not readily accessible.
				31	Inspect terminal blocks for loose connections, cracks, and breaks.
					Clean and tighten connections and mountings for transformers, chokes, potentiometers, and rheostats.



DA AGO Form 11-238 item No.	DA AGO Form 11-239 item No.	Preventive maintenance operations
		<i>Monthly</i>
	32	Inspect transformers T-1, T-2, and T-3 and chokes L-9 and L-12 in the receiver-transmitter power supply for overheating and oil leakage.
	36	Inspect the gaskets located between the panel and case of the auxiliary receiver, the receiver-transmitter, the re-

DA AGO Form 11-238 item No.	DA AGO Form 11-239 item No.	Preventive maintenance operations
		ceiver-transmitter power supply, and the interphone amplifier for wear and leakage.
	37	Check adequacy of moisture-proofing and fungiproof treatment.
	38	If deficiencies noted are not corrected during inspection, indicate what action was taken to correct the deficiencies.

## Section II. TROUBLE SHOOTING

### 93. Scope

a. Trouble shooting at an organizational level is limited to the sectionalizing of trouble to defective units which must be replaced as a unit, or the localizing of defective parts such as tubes, lights, and fuses. When running spares are provided for these defective parts, their replacement can be made in the field. The defective units which must be replaced as a unit should be sent to a maintenance depot for repair.

b. An equipment performance checklist (par. 94) is included primarily as an operational check for the radio set to determine whether the various units perform their functions properly. As a result of these checks, a group of normal indications should be obtained. If in any check the set does not perform as required, the trouble symptoms obtained will point to a faulty component or group of components in the system.

c. Paragraphs 95 through 104 analyze the troubles found by these operational checks and sectionalize these defects to individual components, defective parts, or faulty circuit sections. When trouble is found as a result of an operational check, refer to the paragraph indicated in the checklist and perform the additional checks indicated. The trouble possibilities will narrow down to a related group of circuits and, in some cases, to an individual circuit or part.

d. Actual localization procedure, which will further pinpoint the troubles within the system, will be confined mainly to the taking of resistance measurements. These measurements

are presented in tabular form for the mounting, the interphone box, the chest set group, and the handset.

e. Schematic diagrams of the components of the radio sets and resistor and capacitor color codes are included at the back of this manual for reference.

### 94. Equipment Performance Checklist

#### a. Purpose.

- (1) The equipment performance checklist provides a detailed logical procedure for checking the operation of the radio sets. If the set performs satisfactorily for each check, it may be assumed that the set is in proper operating condition. If the set does not perform satisfactorily as indicated by the checks, a reference is indicated in the checklist to a paragraph which will narrow the troubles down to a smaller number of possibilities or to a specific defect in the system.
- (2) The checklist should be used after the initial installation of the equipment, before the equipment is placed in service, and periodically thereafter as an aid in trouble shooting.

b. Use. The checklist is arranged in the same sequence the operator follows when initially applying power to the equipment. *Each check is made after the preceding checks have been made and the troubles thus discovered have been eliminated.* The operator starts with Item 1 and proceeds in the indicated order.

When he has become familiar with the operation of the equipment, the operator can adapt the list to his own advantage, omitting those steps which do not pertain to the particular unit he wishes to check. The checklist includes the following columns:

- (1) *Item.* This column assigns a numerical sequence to the particular check to facilitate further reference to it.
- (2) *Unit.* This column gives the sequence and name of the units which are to be checked.
- (3) *Action or condition.* This column lists the switches and controls to be operated and, in effect, represents an action to be taken to check the normal

indication given in the normal indications column.

- (4) *Normal indications.* This column includes the visible or audible signs which the operator should note when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measure referred to in the last column.
- (5) *Possible defective units.* This column refers to additional sectionalization and localization checks given in paragraphs 95 through 104. In some cases, this column refers to the specific unit or circuit section suspected of being defective.

### c. Equipment Performance Checklist.

Item No.	Unit	Item	Action or condition	Normal indications	Possible defective units
1	Mounting .....	OFF-REMOTE-ON switch.	Set at OFF.		
2	Mounting .....	Cabling .....	All connections properly made (fig. 27).		
3	Interphone amplifier.	OFF-INT-RT-70 switch.	Set at OFF.		
4	Interphone amplifier.	VOLUME control.	Turn to approximate midpoint of range.		
5	Receiver - transmitter power supply.	OPERATE switch.	Set at OFF.		
6	Receiver - transmitter power supply.	TRANS POWER switch.	Set at HIGH.		
7	Receiver-transmitter.	SQUELCH control.	Turn completely clockwise for maximum squelch operation.		
8	Receiver-transmitter.	VOLUME control.	Turn clockwise for maximum volume at the receiver - transmitter panel.		
9	Receiver-transmitter.	DIAL LIGHT OFF-ON-RING switch.	Set at DIAL LIGHT ON.		
10	Receiver-transmitter.	METER switch ...	Set at 90V.		
11	Auxiliary receiver.	VOLUME control .	Set at OFF.		
12	Auxiliary receiver.	TUNE-DIAL LIGHT (OFF-ON) switch.	Set at DIAL LIGHT ON.		
13	Auxiliary receiver.	SQUELCH control.	Turn completely clockwise for maximum squelch operation.		
14	Interphone box.	Chest set and headset-microphone.	Connect chest set to audio receptacle; plug headset-microphone into chest set.		
15	Interphone box.	RADIO TRANS. switch.	Lock in RADIO TRANS. position.		

Item No.	Unit	Item	Action or condition	Normal indications	Possible defective units
16	Interphone box.	VOL. controls .....	Turn to approximate midpoint of range.		
17	Mounting .....	OFF-REMOTE-ON switch.	Turn to ON .....	Power lamp glows if dimmer is adjusted properly.	Battery, battery cable, lamp E-7, fuses (F-1 and F-2). See table I for power input circuit continuity measurements (par. 102).
18	Interphone amplifier.	OFF-INT-RT-70 switch.	Turn to INT position.		
19	Interphone box (all interphone boxes in use).	Push-to-talk switch on chest set.	Press push-to-talk switch and talk into microphone.	Speech heard in headset.	Interphone circuits. (See par. 96 for sectionalization procedure of these circuits.)
20	Receiver - transmitter power supply.	OPERATE switch.	Turn to TRANS & RECEIVE.	Lamp on Set 1 panel glows.	Set 1 power supply. Set 1 lamp fuses (par. 97).
21	Receiver-transmitter.	METER switch ...	Set at 90V .....	Meter on Set 1 panel reads approximately center-scale (shaded area).	Meter or mounting wiring (par. 97).
22	Receiver-transmitter.	METER switch ...	Turn successively to positions 7 through 11.	Meter on Set 1 panel reads approximately center-scale (in shaded area).	Set 1 (receiver tube filaments or filament circuit component) (par. 98).
23	Receiver-transmitter.	SQUELCH control.	Turn SQUELCH control to extreme counterclockwise (OFF) position.	Rushing noise heard in headphones. Adjust VOL. control on interphone box for comfortable noise level.	Set 1 receiver, mounting, amplifier, or cables (par. 99).
24	Receiver-transmitter.	SQUELCH control.	Turn SQUELCH control in a clockwise direction.	Rushing noise disappears.	Defective Set 1 receiver squelch circuits (par. 99b).
25	Receiver-transmitter.	Tuning controls ...	Tune in signal .....	Signal heard in headset.	Set 1 receiver (par. 99c).
26	Interphone box.	RADIO TRANS. ..	Lock in clockwise RADIO TRANS. position.		
27	Interphone box.	Selector switch ....	Turn to Set 1 AUX REC INT position.		
28	Chest set .....	RADIO-INT switch.	Hold in the RADIO position.		
29	Chest set .....	Push-to-talk switch.	Press switch and talk into microphone.	Sidetone signal is heard in headset and transmitted signal is received by another radio set.	Transmitter.
30	Set 1 .....	METER switch.	Turn METER switch successively to positions 2 through 6.	Meter reads approximately center-scale for each switch position.	Set 1 transmitter tube filaments or control circuits (par. 98).



Item No.	Unit	Item	Action or condition	Normal indications	Possible defective units
31	Set 1 .....	METER switch.	Turn METER switch to RF position.	Meter reads approximately $\frac{1}{2}$ full scale.	Set 1 transmitter, Set 1 power supply, or special purpose cable CX-1211/U (par. 100).
32	Receiver-transmitter.	DIAL-LIGHT OFF-ON-RING switch.	Hold at Ring position ..	Meter reads at least $\frac{1}{2}$ of full scale. Dial light goes on, and a 1,600-cycle sidetone is heard in headphones.	Check tube V-104 in Set 1. Check RING switch (TM 11-289).
33	Auxiliary receiver.	VOLUME control.	Turn clockwise.		
34	Auxiliary receiver.	TUNE-DIAL LIGHT (OFF-ON) switch.	Turn to DIAL LIGHT ON.	Lamp on receiver panel glows.	Filament supply circuits lamp, mounting, auxiliary receiver power supply, or cable (par. 101).
35	Auxiliary receiver.	SQUELCH control.	Turn SQUELCH control to extreme counterclockwise position (OFF).	Rushing noise (assuming no incoming signal) is heard in headset.	Cable W-2, defective auxiliary receiver, or defective plug-in power supply (par. 101b).
36	Auxiliary receiver.	VOLUME control.	Attach handset or chest set and headset-microphone to the AUDIO receptacle on auxiliary receiver panel; turn VOLUME control in counterclockwise direction; listen on panel-mounted audio unit.	Volume of rushing noise decreased gradually as control is rotated.	Defective volume control (TM 11-898).
37	Auxiliary receiver.	SQUELCH control.	Turn SQUELCH control in clockwise direction.	Rushing noise disappears abruptly.	Check tube V-11 (par. 101).
38	Auxiliary receiver.	TUNE-DIAL LIGHT (OFF-ON) switch.	Turn to TUNE position (with SQUELCH control in extreme clockwise position).	Dial light goes on. Receiver is quiet (squelched) except at calibration points (multiples of 4.3 mc) where a beat note is heard.	Tuning oscillator. Check tube V-10.
39	Auxiliary receiver.	SQUELCH control; TUNING dial.	Turn to OFF. Tune dial to frequency of signal transmitted from another radio set.	Beat note is heard at some point of the dial at or near a red dot calibration. Rushing noise is reduced considerably.	Check all receiver tubes (par. 101).
40	Auxiliary receiver.	VOLUME control.	Turn to OFF .....	Lamp on receiver panel extinguishes.	
41	Mounting .....	OFF-REMOTE-ON switch.	Turn to OFF until item 54 is completed. Then turn on.	Lamps on mounting and receiver-transmitters go out while switch is OFF.	

Item No.	Unit	Item	Action or condition	Normal indications	Possible defective units
42	Control Group AN/GRA-6.		Install as outlined in paragraphs 121 through 124.		
43	Chest set (with headset - microphone).	AUDIO receptacle at local control.	Connect to local control unit. Lock RADIO-INT switch in RADIO position.		
44	Headset .....	AUDIO receptacle at remote control.	Connect to remote control unit (par. 124).		
45	Local and remote units.	REMOTE and SELECTOR switches.	Turn to TEL ONLY and TEL, respectively.		
46	Local and remote units.	Signal selector switches (internal).	Set to BELL position on each unit.		
47	Local control unit.	Ring generator.	Crank generator during items 47, 48, and 49. Listen in headset.	Ring signal heard in headphone at local unit.	Defective generator or T-1 in local unit (TM 11-5038).
48	Remote control unit.	Handset .....	Listen in earpiece of handset at remote unit.	Bell rings. Ring signal heard in earpiece at remote unit.	Remote control unit, telephone line, or handset (TM 11-5038).
49	Remote control unit.	Ring switch (internal).	Turn to CALL LIGHT position.	CALL LIGHT on panel of remote unit goes on.	Defective call lamp or ring switch in remote unit. Replace call light E-3. Check switch (TM 11-5038).
50	Remote control unit.	Ring generator.	Crank generator during items 50, 51, and 52. Listen in earpiece of handset.	Ring signal heard in earpiece at remote unit.	Remote unit, or handset (TM 11-5038).
51	Local control unit.	Headphones .....	Listen in headphones ..	Bell rings and ringing signal is heard in headphone at local unit.	Remote or local unit (TM 11-5038).
52	Local control unit.	Ring switch (internal).	Turn to CALL LIGHT position.	CALL LIGHT on panel of local unit goes on.	Defective call light or ring switch in local unit (TM 11-5038).
53	Remote control ....	Handset .....	Operate microphone push-to-talk switch, and talk into microphone. Listen in earpiece.	Local operator hears remote operator. Remote operator hears sidetone in own earpiece.	Remote unit, or microphone portion of handset at remote unit (TM 11-5038).
54	Local control ....	Chest set .....	Operate push-to-talk switch and talk into microphone. Listen in headphones.	Remote operator hears local operator. Local operator hears own speech.	Local unit or remote unit (TM 11-5038).
55	Local Control unit.	REMOTE switch.	Place in the SET 1 position.		
56	Mounting .....	OFF-REMOTE-ON switch.	Place in ON position ..	POWER lamp on mounting lights. Set 1 lamp goes on.	
57	Chest set .....	Push-to-talk switch.	Lock in talking position.	Meter on Set 1 panel shows r-f output (Meter in RF position).	

Item No.	Unit	Item	Action or condition	Normal indications	Possible defective units
58	Local control unit.	LOCAL switch ....	Hold in SET 1 position, talk into microphone, and listen in headphones.	Sidetone heard in headphones.	Local control, mounting, cable W-3 (TM 11-5038).
59	Local control unit.	LOCAL switch ....	Release switch .....	Sidetone disappears.	Defective LOCAL switch (spring return) on local unit (TM 11-5038).
60	Mounting .....	OFF-REMOTE-ON switch.	Turn to Remote position.	All panel lamps extinguish.	See TM 11-5038.
61	Remote control unit.	SELECTOR switch.	Turn to left-hand write-in position.		
62	Local control unit.	REMOTE switch ..	Turn to SET 1 position.		
63	Local control unit.	Chest set .....	Listen in earphones until item 66 is completed.	Meter on Set 1 panel indicates r-f output (½ full scale). No sound is heard in headphones at local unit (unless the auxiliary receiver or the interphone amplifier is receiving a signal).	
64	Set 1 .....	METER switch ...	Turn to RF position.		
65	Remote control unit.	Handset push-talk switch.	Press push-to-talk switch.		
66	Remote control unit.	Handset .....	Talk into microphone ..	Speech heard in headphones at remote and local units.	See TM 11-5038.
67	Remote control unit.	SELECTOR switch.	Turn SELECTOR switch to right-hand write-in position.	Set 1 transmitter is turned off (meter shows no r-f output).	Defective local control or remote control unit (TM 11-5038).
68	Remote control unit.	Handset .....	Press push-to-talk switch and talk into microphone.	Set 1 power is turned off. No sidetone is heard.	See TM 11-5038.
69	Mounting .....	Power switch ....	Turn to OFF.		

## 95. General Sectionalization or Localization Procedures

a. The following paragraphs include sectionalization or localization procedures indicated on the equipment performance checklist (par. 94-c) to remedy defects in the radio set.

b. Most abnormal indications are caused by a specific unit or circuit within the system. The following paragraphs will help the operator analyze the defective condition and narrow down the possible causes of trouble. This analysis of operating defects takes the form of

additional checks the operator should perform to disclose the source of an abnormal indication.

c. The additional checks should be performed in a detailed and logical manner. Once the defective condition is corrected, the original operating check again should be performed. If the operation is then normal, the system should be considered in proper working order up to the next item in the checklist.

d. Whenever the procedure calls for checking a part, substitute, if possible, an identical part known to be in good condition. A running



spare, if provided, should be substituted when a particular part is suspected. Paragraphs 105 to 111 describe procedures to be followed when replacing parts.

## 96. Interphone Circuits, Sectionalized Procedure

(items 18 and 19, par. 94c)

If speech is not heard in the headset when items 18 and 19 of the equipment performance checklist are performed, the following procedures will aid in locating the trouble. Refer to the main control circuit (fig. 94) for an understanding of the procedures which are described.

*a.* Turn VOL. control on the interphone box (the knob near the audio receptacle into which the cable is plugged) in a clockwise and then in a counterclockwise direction. If speech is heard when the knob is turned in a clockwise direction, the VOL. control was probably set too low initially. If speech is heard when the VOL. control is turned in a counterclockwise direction, a defective VOL. control potentiometer is indicated. If neither of these operations results in speech being heard, remove the cable from the audio receptacle on the interphone box and connect it to the audio receptacle on the opposite side of the interphone box. With the VOL. control on that side of the interphone box set at maximum (extreme clockwise), listen for speech signals. If speech is heard, the first VOL. control used is probably defective. If speech signals still are not heard, replace the chest set, headset, and microphone with others known to be operative. If speech is now heard, one of these (originally used) audio accessories is defective. If speech still is not heard, continue with *b* below.

*b.* Set the RADIO-INT switch on the chest set in the RADIO position. Lock the RADIO TRANS switch on the control box at the clockwise RADIO TRANS position. Set the selector switch in the INT position. If speech is now heard when the push-to-talk switch is pressed, a defective RADIO-INT switch is indicated, or the wiring to this switch is incorrect. If speech is still not heard, the selector switch or the RADIO TRANS switch or the wiring to these two switches is defective. Proceed with *c* below.

*c.* Connect a chest set, headset, and microphone (known to be operative) to the AUDIO connector on the panel of the interphone amplifier. If speech is now heard, there is some defect in the wiring to the previously operated switches or in the switches themselves. If speech is still not heard, there is a defect in the interphone amplifier or in its plug-in power supply. Proceed with *d* below.

*d.* Check fuse F-1 (fig. 8) and tubes V-1, V-4, and V-5 in the amplifier (fig. 46). Also check to see that the power supply is plugged firmly into the amplifier and check the vibrator E-1 (fig. 47). If speech is still not heard after the above-mentioned parts have been replaced, refer to TM 11-5039 and TM 11-5040 respectively for detailed checks of the interphone amplifier and its plug-in power supply.

## 97. Receiver-Transmitter Power Supply Sectionalization

(items 20 and 21, par. 94c)

*a.* When normal indications are not obtained for item 20 of the checklist, the following should be done:

- (1) Turn the meter switch on the receiver-transmitter to position 7 (par. 98). If a normal indication is obtained on the meter, replace lamp E-313 (par. 109). If the meter reads zero, replace tube A/V-116 (par. 109).
- (2) Check fuse F-1 in the receiver-transmitter power supply (fig. 5 and par. 108).

*Note.* If the tube filament of V-116 is defective (par. 98), the pilot light will not go on for any position of the DIAL LIGHT OFF-ON-RING switch. The circuit to the filaments of tubes V-113, V-114, and V-3 also will be open.

- (3) Check the mounting wiring to the receiver-transmitter power supply circuits (cable W-5, terminals B and C (par. 102)).
- (4) If this fails to clear the trouble, a point-to-point check of the lamp circuit in the receiver-transmitter is necessary. See TM 11-289.

*b.* When normal indications are not obtained for item 21, make the squelch check (items 23, 24, 25).

- (1) If noise is heard, there is a defective meter circuit in the receiver-transmitter. Refer to TM 11-289 for detailed checks of the metering circuit.
- (2) If noise is not heard, the trouble may be in the receiver-transmitter power supply. Try replacing vibrator E-3 (fig. 50) and voltage regulator V-4. If this fails to clear the trouble, refer to TM 11/5036 for detailed checks of the 85-volt supply circuits in the receiver-transmitter power supply.

## 98. Receiver-Transmitter Filament Check (items 22, and 26 through 30)

If an abnormal indication is obtained in any position of the METER switch, there must be a defective tube filament or filament circuit component.

a. The following chart lists the receiver-transmitter tubes checked for each position of the METER switch on the panel. A center-scale reading is the normal reading for all positions of the switch. If the normal reading is not obtained, the probable defective tube (that is, a defective tube filament) is listed under the type of reading obtained.

METER switch position	Zero reading	Too low but not zero reading	Too high but not full-scale reading	Full-scale reading
2	V-7	V-7	V-9	V-9
3	V-8	V-8	V-10	V-10
4	V-6			V-5
5	V-106	V-106		V-104
6	V-105			
7	V-116	V-114	V-113, V-3	V-3
8	V-4 (one-half of filament)	V-4 (other half of filament)	V-2	V-2
9	V-102			V-107, V-103
10	V-108, V-110		V-112	V-111, V-112
11	V-115		V-109, V-101	V-109, V-101

*Note.* If the pilot light on Set 1 is on when the DIAL LIGHT OFF-ON-RING switch is in the DIAL LIGHT ON position, the filament of V-116 is normal. This may be an additional check. If the filament of V-116 is defective, the circuit to the filaments of tubes V-113, V-114, and V-3 also will be open.

b. The filaments of the transmitter power amplifier tube V-11 and the first r-f amplifier tube V-1 are not checked by the METER switch. These tubes must be checked by visual inspection. Observe whether (with power ap-

plied) the tubes light. The filament of V-11 is energized when the microphone push-to-talk button is operated.

c. Because of the series-parallel arrangement of the tube filaments (fig. 83), a break in the filament of one tube in a string of tubes will cause all the other tubes in the string to go out and will produce indications of a faulty stage involving those tubes.

d. A low voltage reading on the meter for tubes in positions 7 through 11 (item 22) may be due to faulty ballast tubes R-31 and R-40 or to a faulty K-2 thermal relay in the receiver-transmitter power supply. Check these by substitution.

e. Failure to obtain a reading at some but not all filament meter switch positions indicates that a filament string is defective. Refer to the filament check chart (a above).

f. Failure to obtain a reading at switch positions 2 through 6 of the METER switch (item 30) indicates that the transmit control circuits within the receiver-transmitter or in the mounting, interphone box, or receiver-transmitter power supply may be defective.

- (1) Connect a handset (known to be good) to an AUDIO receptacle on the Set 1

panel. Operate the push-to-talk switch. If meter readings are now obtained, the trouble is in the interphone box or the mounting.

- (a) Disconnect the REC TR CONTROL cable (W-3) from the receiver-transmitter (fig. 27).
- (b) Check the continuity of the receiver-transmitter control circuit in the interphone box (terminal 1 of E-2



to ground) with the push-to-talk switch operated (par. 103).

- (c) Check the connection between terminal K of P-3 on W-3 to terminal 1 of E-2 in the interphone box. An infinite reading between these points indicates a broken wire in Special Purpose Cable WM-46/U.
- (2) If METER readings on positions 2 through 6 are still not obtained with the push-to-talk switch operated at the AUDIO receptacle of the receiver-transmitter, the trouble is in the receiver-transmitter power supply or in the receiver-transmitter control circuits.
  - (a) Check ballast tubes R-24 and R-25 in Power Supply PP-109/GR. In Power Supply PP-112/GR, check ballast tubes R-24, R-25, R-37, and R-38 (figs. 48 and 49).
  - (b) Check thermal relay K-1 in the receiver-transmitter power supply.
  - (c) Check the transmitter relay supply circuits in the receiver-transmitter power supply (see TM 11-5036).
  - (d) Check the transmitter filament circuits in the receiver-transmitter (fig. 83).
  - (e) Check the continuity of lead N in Special Purpose Cable Assembly CX-1211/U.

## 99. Receiver-Transmitter, Receiver Operational Check

*a. Over-All Receiver Operation.* If a check of item 23 shows a trouble condition, proceed as follows until the defect is located:

- (1) Plug an audio accessory (known to be in proper working order) into one of the AUDIO receptacles on the receiver-transmitter panel. If noise is now heard, check the wiring within the mounting which links the fixed level audio output of the receiver-transmitter to the Set 1 output of the interphone amplifier (terminal 8 of E-6 to terminal F of E-5) (par. 102). Check tube V-102 in the receiver-transmitter.
- (2) Check the wiring in the mounting which goes to terminals H and J of

P-3 (fig. 78). Check connections from P-3 to E-6 (fig. 19).

- (3) Make the sidetone check (item 32). If sidetone is heard, check tubes V-2, V-107, and V-108 (figs. 53 and 54). If sidetone is not heard, check tubes V-109 through V-114 and V-101, V-3, and V-4. If a signal is heard at an AUDIO receptacle on the panel of the receiver-transmitter but not at the interphone box, check V-102 only. If a signal is heard at the interphone box but not at an AUDIO receptacle, check tube V-115 only. If a signal is heard in the headphones but not in a loudspeaker connected to an AUDIO receptacle, check tube V-116 only.

*b. Squelch Circuit Operation.* If the rushing noise heard in the headset (item 23) but does not disappear when the SQUELCH control is advanced in a clockwise direction (item 24), check squelch oscillator tube V-103 and the components of the squelch circuit (see TM 11-289).

*c. Over-All Receiver Operation, Listening Check.* If no signals are heard in the check of item 25, paragraph 94c, trouble exists in the Set 1 receiver r-f or i-f circuits. To isolate the trouble between these two portions of the receiver, perform the ringing check of item 32.

- (1) If a ringing sidetone is heard, check tubes V-1, V-2, V-107, and V-108. If tube substitutions fail to clear the trouble, the r-f and variable i-f parts of the receiver circuits must be checked in detail (see TM 11-289).
- (2) If a ringing sidetone is not heard, check tubes V-107 through V-114, V-101, and V-103. Repeat the listening check.

*Note.* A no-sidetone condition also may be the result of a fault in the l-f (low-frequency) portion of the transmitter, the transmitter control circuits, or the transmitter power supply circuits. Proceed with item 23, paragraph 94c, to analyze these circuits.

## 100. Receiver-Transmitter, Transmitter Operational Check (item 31, par. 94c)

Failure to obtain a reading of the r-f meter may be due to a fault in any of the transmitter



power supply circuits (90-volt, 150-volt, or 300-volt supply circuits), the receiver-transmitter control circuits (relay A/O-301, A/O-1, or A/O-101), Special Purpose Cable Assembly CX-1211/U, or the transmitter section of the receiver-transmitter.

a. Check fuses F-2, F-3, and F-4 in the receiver-transmitter power supply (fig. 48 and par. 108).

b. Make a sidetone check by talking into the microphone and listening for sidetone. If sidetone is heard, perform the following steps:

- (1) Check tubes V-3 through V-11 (by replacement).
- (2) Check the h-v power supply contacts of relays A/O-1 and E/O-1 in the receiver-transmitter and receiver-transmitter power supply respectively. Refer to TM 11-289 and TM 11-5036.
- (3) Check leads B, R, P, F, and C (on V/P-1 and V/P-2) in Special Purpose Cable Assembly CX-1211/U.
- (4) Check vibrators E-1 and E-2 in the receiver-transmitter power supply (fig. 50).

c. If no sidetone is heard, check tubes V-104 through V-106. Refer to TM 11-289 and TM 11-5036 to make detailed checks of the l-v supply circuits in the receiver-transmitter power supply and the l-v supply circuits in the receiver-transmitter.

## 101. Auxiliary Receiver Operation

Connect a chest set to the AUDIO receptacle of the auxiliary receiver.

a. *Filament Supply Circuits.* The lighting of the dial lamp indicates that filament voltage is being made available to all receiver tubes (fig. 41). Refer to items 33 and 34, paragraph 94c. If the lamp does not light, make the following checks:

- (1) Check fuse F-1 in the receiver (par. 110 and fig. 51).
- (2) Check dial LAMP E-14.
- (3) Turn TUNE-DIAL LIGHT (OFF-ON) switch to the TUNE position. If the lamp lights in that position, the ON position of the switch is defective or incorrectly wired.
- (4) Check the continuity of lead B in cable W-1 and in the mounting.

- (5) If the lamp still does not light, refer to TM 11-898 (filament supply circuits).

*Note.* Make sure that the proper plug-in power supply is inserted.

b. *Over-All Receiver Operation* (item 35). If no noise is present, if the dial LAMP is lit, and if the filament of each tube has been checked for continuity, make the following checks:

- (1) Check thermal relay K-1 in the receiver (fig. 55).
- (2) Check continuity of terminals H and B of cable W-2 (par. 102).
- (3) Check vibrator E-1 in plug-in power supply.
- (4) See TM 11-898 for receiver trouble sectionalizing checks.

c. *Squelch Operation* (item 37). If the rushing noise does not disappear, check tube V-11. If it still does not disappear, see TM 11-898 (receiver trouble sectionalizing checks).

d. *Calibration Check* (item 39). If beat note signal is not heard at the calibration points listed below, check tube V-10. If still no signal is heard, check tubes V-1 through V-10.

Radio receiver	Calibration frequency (mc)
R-108/GRC	21.5, 25.8
R-109/GRC	30.1, 34.4, 38.7
R-110/GRC	38.7, 43, 47.3, 51.6

## 102. Localization Measurements in Mounting MT-297/GR

a. Table I lists the continuity measurements which can be made in the mounting. These measurements are arranged according to individual circuits or stages of operation within the system. This arrangement simplifies the checking of specific wiring in the mounting.

b. Electrically disconnect all components from the mounting.

c. When making continuity measurements, refer to the schematic diagram of the mounting (fig. 78).

Table I. Point-To-Point Resistance Measurements, Mounting MT-297/GR

Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble	Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble
Set 1 circuits for operation from interphone box.					From term. 10 of E-6 to term. A of P-7.	0	Wiring.
Transmission.	From term. 5 of E-6 to term. C of P-3.	0	Wiring.	Miscellaneous.	From term. 4 of E-6 to chassis.	0	Wiring.
	From term. 1 of E-6 to term. K of P-3.	0	Wiring.	Power input circuits.			
	From term. D of P-3 to chassis.	0	Wiring.	Battery connections.	From + term. of battery cable to term. B2 of relay K-1.	Almost zero	Wiring, open fuse F-1.
Reception.	From term. B of P-3 to term. B of P-7.	0	Wiring Contacts 2-3 of relay O-1.		From + term. of battery cable to — term. of battery cable.		
	From term. H to term. J of P-3.	0	Wiring, contacts 4-5 of relay O-1.		S-1 in OFF position.	Infinity	Wiring, grounded switch S-1, contacts of K-1 stuck.
	From term. 8 of E-6 to term. F of P-7.	0	Wiring.		S-1 in REMOTE position.	Infinity	Wiring, grounded switch S-1, contacts of K-1 stuck.
Auxiliary receiver operation from interphone box.	From term. H to term. J of P-2.	0	Broken strap connection between terminals H1 and J1 of terminal strip E-2.		S-1 in ON position.	55.5 (24 v) 27.5 (12 v)	Wiring, broken battery cable, open or shorted R-3, open or shorted coil of K-1, open fuse F-1.
	From term. B of P-2 to term. B of P-7.	0	Wiring, contacts 2-3 of relay O-1.		From — term. of battery cable to chassis.	0	Broken battery cable.
Interphone operation from interphone box.							
Transmission.	From term. 6 of E-6 to term. C of P-7.	0	Wiring.				
	From term. 2 of E-6 to term. K of P-7.	0	Wiring.				
Reception.	From term. 9 of E-6 to term. H of P-7.	0	Wiring.	Auxiliary receiver power input circuit.	From term. B of P-1 to term. B1 of relay K-1.	0	Wiring.
	From term. 8 of E-6 to term. F of P-7.	0	Wiring.		From term. C of P-1 to chassis.	0	Wiring.

Table I. Point-To-Point Resistance Measurements,  
Mounting MT-297/GR—Continued

Circuit or stage	Point of measurement	Normal reading (ohms)	Probable trouble
Set 1 power input circuit.	From term. B of P-1 to chassis.	165	Wiring or defective lamp E-7.
	From term. B of P-5 to term. B1 of relay K-1.	0	Wiring.
	From term. C of P-5 to chassis.	0	Wiring.
	From term. B of P-5 to chassis.	165	Wiring or defective E-7.

### 103. Localization Measurements in Control Box C-375/VRC

Table II lists point-to-point resistance measurements within Control Box C-375/VRC. These measurements are intended to localize trouble within that unit after the preceding trouble-shooting checks have pointed to it as a possible source of trouble. The data are so arranged that only those circuits within the control box associated with the nonoperating radio component, or a particular function of that component, need be checked. In addition, the checks are grouped according to the type of audio accessory (handset, chest set, or jack-connected audio accessory) used for making the checks. Thus, if the trouble sectionalization checks show that with a handset used as an audio accessory the Set 1 transmit control circuits are faulty, check only those circuit sections grouped under the title *Set 1 transmission (handset connections)*.

Table II. Point-To-Point Resistance Measurements, Control Box C-375/VRC

Circuit section	Point of measurement	Test conditions	Nominal reading (ohms)	Probable trouble
Set 1 circuits (handset connections)	From term. C of J-1 or J-2 to term. 5 of E-2.	S-2 in either RADIO TRANS, S-1 in SET 1 + INTERPHONE.	0	Defective S-2 (A1 or A3) or S-1 (A1).
	From term. F of J-1 or J-2 to term. 1 of E-2.	Same as above.	0	Defective S-2 (B1 or B3) or S-1 (C-1).
	From term. A of J-1 to term. 8 of E-2.	Same as above, VOL. control R-1 in extreme clockwise position.	0	Defective R-1, strap connection between terminals 13 and 14 of E-2 missing, or defective S-1 (B1).
	From term. A of J-2 to term. 8 of E-2.	Same as above except that VOL. control R-2 is in extreme clockwise position.	0	Defective R-2, strap connection between terminals 13 and 15 of E-2 missing, or defective S-1 (B1).
	From term. A of J-1 to term. 13 of E-2.	Rotate VOL. control R-1 in counterclockwise direction.	Resistance increases from 0 to 10K.	Defective R-1.
	From term. A of J-2 to term. 13 of E-2.	Rotate VOL. control R-2 in counterclockwise direction.	Resistance increases from 0 to 10K.	Defective R-2.
	From term. E of J-1 or J-2 to chassis.		0	Open ground connection.
	From term. H of J-1 or J-2 to chassis.		0	Open ground connection.
	From term. B of J-1 or J-2 to chassis.		0	Open ground connection.



Table II. Point-To-Point Resistance Measurements, Control Box C-375/VRC—Continued

Circuit section	Point of measurement	Test conditions	Nominal reading (ohms)	Probable trouble
Interphone circuits (handset connections).	From term. 4 of E-2 to chassis.		0	Open ground connection.
	From term. C of J-1 or J-2 to term. 6 of E-2.	S-2 in interphone position.	0	Defective S-2 (A2).
	From term. F of J-1 or J-2 to term. 2 of E-2.	S-2 in either RADIO TRANS position, S-1 in center position.	0	Defective S-2 (B1 or B3) or S-1 (C2).
	From term. F of J-1 or J-2 to term. 2 of E-2.	S-2 in interphone position.	0	Defective S-2 (B2).
	From term. A of J-1 (or J-2) to term. 9 of E-2.	VOL. control R-1 (or R-2) in extreme clockwise position, an S-1 in center position.	0	Defective R-1 (or R-2), S-1 (B2), missing strap between terminals 13 and 14 (or 13 and 15) of E-2.
	Check volume controls as in fifth and sixth items under Set 1 circuits above.			
Interphone circuits (chest set connections).	Check ground connections as in last four items under Set 1 circuits above.			
	From term. K of J-1 or J-2 to term. 6 of E-2.		0	Wiring.
Set 1 circuits (chest set connections).	Repeat the six items under <i>Interphone circuits (handset connections)</i> above.			
	From term. J of J-1 or J-2 to term. 2 of E-2.		0	Wiring.
Jack connections.	Check the 10 items under <i>Set 1 circuits (handset connections)</i> above.			
	From tip of J-3 or J-4 to term. C of J-1 and J-2.		0	Wiring or defective jack.
	From ring of J-3 or J-4 to term. F of J-1 and J-2.		0	Defective jack or lead.
	From sleeve of J-3 or J-4 to chassis.		0	Open ground connection.
	From tip of J-6 to A of J-1.		0	Defective jack or lead.
	From tip of J-5 to A of J-2.		0	Defective jack or lead.
	Check the connections made for the <i>Set 1 circuits</i> or the <i>Interphone circuits</i> above, depending on whether the Set 1 or the Interphone circuits are to be checked.			

# 104. Continuity Measurements in Handset H-33/PT and Chest Set Group AN/GSA-6

Tables III and IV give resistance measurements for the principal audio accessories used with Radio Sets AN/VRC-20, -21, and -22.

a. These measurements are intended to locate defects within these units after the preceding trouble-shooting checks have pointed to them as a possible source of trouble.

b. Refer to figure 80 when taking the measurements.

Table III. Point-To-Point Resistance Measurements, Handset H-33/PT

Point of measurement	Required reading (ohms)	Test condition
Between terminals A and B.	30 ohms, approximately; click heard when making or	None.

Point of measurement	Required reading (ohms)	Test condition
Between terminals F and H.	0	Push-to-talk switch operated.
Between terminals F and H.	Infinity.	Push-to-talk switch unoperated.
Between terminals E and D.	0	Push-to-talk switch operated.
Between terminals E and D.	Infinity.	Push-to-talk switch unoperated.
Between terminals D and C.	150 ohms, approximately; click heard when making or breaking ohmmeter connection.	None.
Between terminals F and D.	Infinity.	Push-to-talk switch operated or unoperated.

Table IV. Point-To-Point Resistance Measurements, Chest Set Group AN/GSA-6 with Headset-Microphone H-63/U

Circuit section	Point of measurement	Test condition	Nominal reading (ohms)	Probable trouble
Headset.	From term. A to term. B of cable connector plug.	Headset-microphone H-63/U connected for all measurements in this table.	60 ohms, approximately; click heard when making or breaking ohmmeter connections.	Defective headset or wiring.
Microphone.	From term. K to term. E of cable connector.	Push-to-talk rocker arm unoperated; RADIO-INT switch in INT position.	Infinity.	Defective push-to-talk switch.
	From term. C to term. E of cable connector.	Push-to-talk rocker arm in each of two operated positions; RADIO-INT switch in INT position.	150 ohms, approximately; click heard when making or breaking ohmmeter connections.	Defective push-to-talk switch; RADIO-INT switch or microphone.
Push-to-talk control circuit.	From term. J to term. H of cable connector.	Same as above; RADIO-INT switch in RADIO position.	150 ohms, approximately; click heard when making or breaking test connections.	Defective RADIO-INT switch.
		Push-to-talk switch unoperated; RADIO-INT switch in INT position.	Infinity.	Defective push-to-talk switch.
	From term. F to term. H of cable connector.	Push-to-talk switch operated to each of two positions; RADIO-INT switch in INT.	0	Defective push-to-talk switch or RADIO-INT switch.
		Same as above; RADIO-INT switch in RADIO position.	0	Defective RADIO-INT switch.

## Section III. REPLACEMENT OF PARTS

### 105. General

After trouble has been sectionalized to a particular unit, it must be localized to a particular component part or circuit of this unit. This section lists procedures for the replacement of parts. Running spares for each unit are listed in paragraph 19.

### 106. Removing Immersionproof Cases

The replacement of pluck-out parts (except fuses) requires removal of the immersionproof cases which house the panel-chassis assemblies of the various units. To remove the case of the receiver-transmitter, the interphone amplifier, the receiver-transmitter power supply, or the auxiliary receiver, perform the following steps:

a. Remove all external connections from the unit involved.

b. Remove the unit from the mounting.

c. Loosen the Dzus fasteners located at the edges of the unit.

d. Slide the panel-chassis assembly out of the case. Be careful not to damage any wiring or components while removing and handling the panel-chassis assembly.

### 107. Interphone Amplifier

The replacement of pluck-out parts for which running spares are available is described in *a* through *d* below.

a. *Fuse*. The panel-mounted fuse is removed by unscrewing the fuse cap, which also serves as a fuse extractor. A spare fuse is located in a fuse clip on the amplifier chassis (fig. 46).

b. *Thermal Relay and Ballast Tube*. Thermal relay K-1 and ballast tube R-32 are mounted in a horizontal position at the rear of the amplifier chassis (fig. 46). After removing the panel-chassis assembly from the case, remove the relay and/or ballast tube with a straight horizontal pull. Do not rock or jiggle the component in its socket. The socket prongs may be damaged.

*Note*. Electrolytic capacitor C-1 (fig. 46) also may be removed.

c. *Tubes*. All tubes are accessible from the top of the chassis when the case has been removed (fig. 46). To remove a tube, first remove

the tube shield and then use a tube puller. If a tube puller is not available, pull up the tubes with your fingers, using a straight upward pull. Do not rock or jiggle a tube in its socket. The tubes are damaged easily by careless handling.

d. *Plug-In Power Supply*. Although it can be replaced as a single unit, the plug-in power supply is not furnished as a running spare. However, a spare vibrator is provided with the power supply (fig. 47). Remove the amplifier case and replace the vibrator as follows:

(1) Loosen the clamp bracket at the rear of the power supply compartment and swing it out of the way.

(2) Grasp the handle at the rear of the power supply unit and pull it straight out.

(3) Remove the three green screws which fasten the top cover on the power supply chassis.

(4) Using the handle on the cover, lift the cover off with a straight upward movement. If the cover is stuck, pry gently with a small screw driver.

(5) Pull vibrator E-1 (fig. 47) from its socket with a straight upward movement. Do not rock or jiggle the vibrator while attempting to remove it. If necessary, use a small screw driver to pry the vibrator gently from its socket. Be careful not to enlarge the ring clip which holds the vibrator near the base.

### 108. Receiver-Transmitter Power Supply

The replacement of pluck-out parts for which running spares are available is described in *a* through *d* below.

a. *Fuses*. The panel-mounted fuses are removed by unscrewing the fuse caps, which also serve as fuse extractors. Spare fuses are located in the front-panel compartment marked SPARE FUSES. To gain access to the spares, loosen the two wingnuts which hold the cover plate of the compartment. Remove the plate.

b. *Thermal Relays and Ballast Tubes*. To gain access to the thermal relays and ballast tubes, remove the panel-chassis assembly from the case (par. 106). All of these parts are acces-



sible from the top of the chassis (figs. 48 through 51). Remove the relays or ballast tubes in the same manner as any standard octal-base tube. Pull them straight upward. Do not rock

or jiggle the components in their sockets. (Note that similarly designated parts are located somewhat differently in the 12- and 24-volt supplies as shown on figures 48 and 49.)

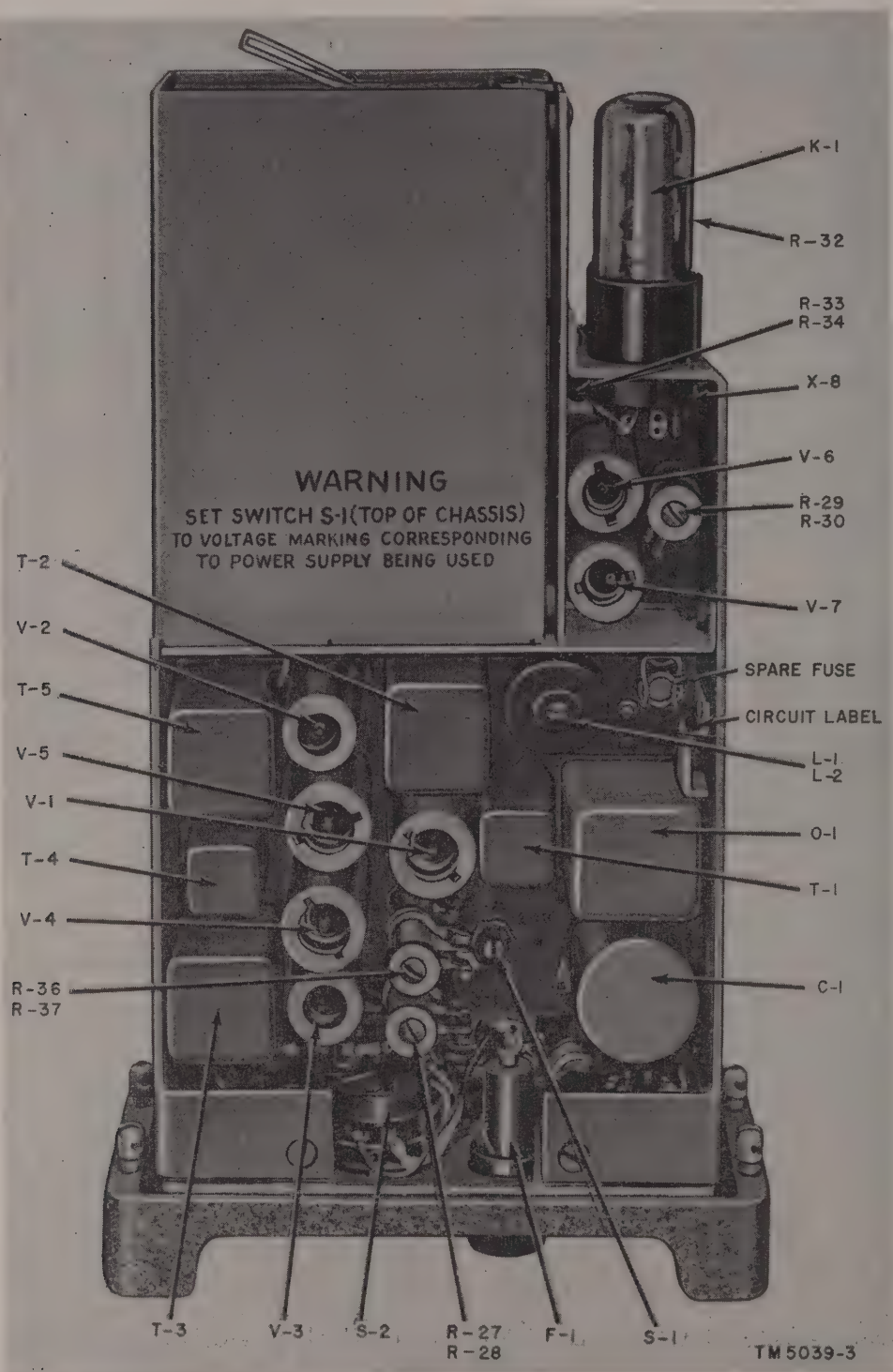
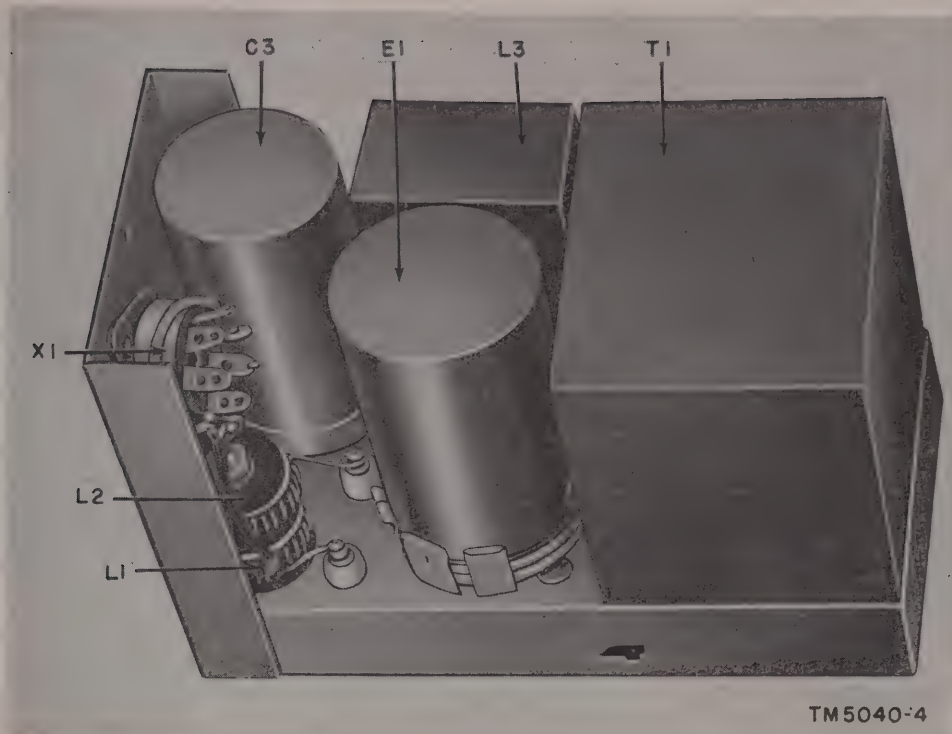
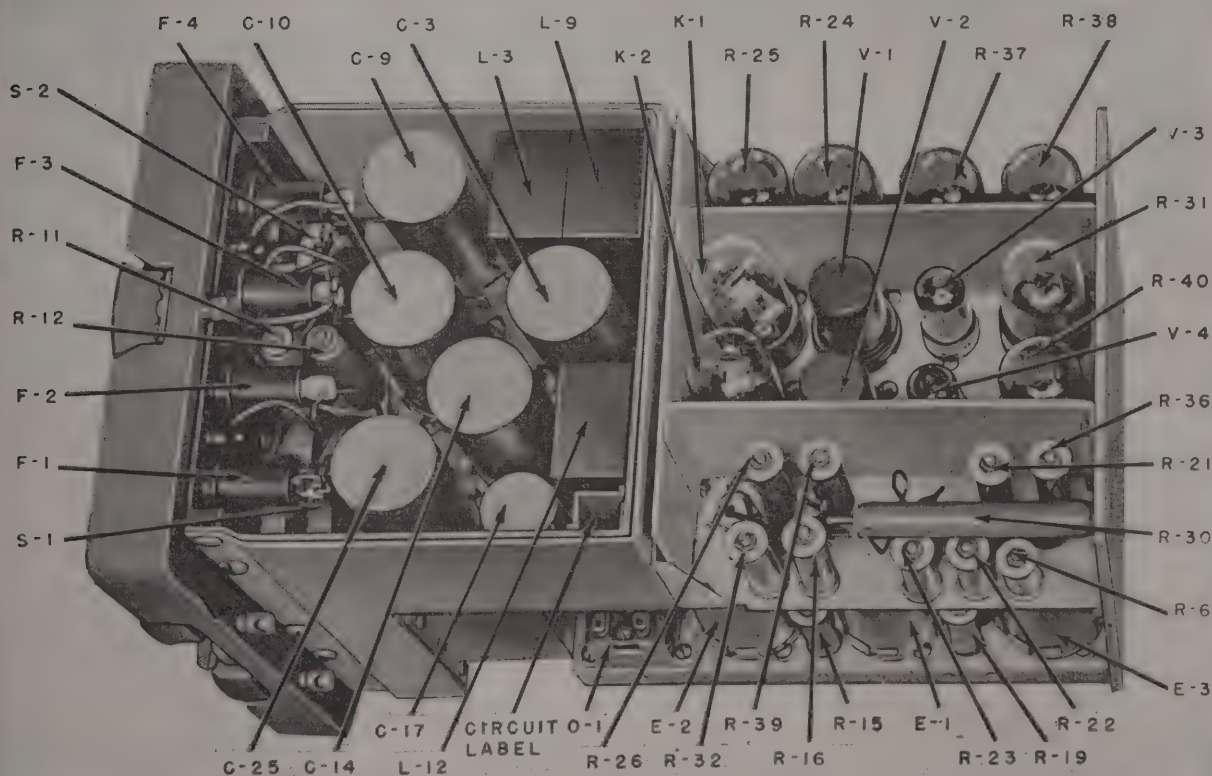


Figure 46. AF Amplifier AM-65/GRC, top view of chassis.



TM5040-4

Figure 47. Power Supply PP-282/GRC, top view of chassis.



TM5036-3

Figure 48. Power Supply PP-112/GR, top view of chassis.



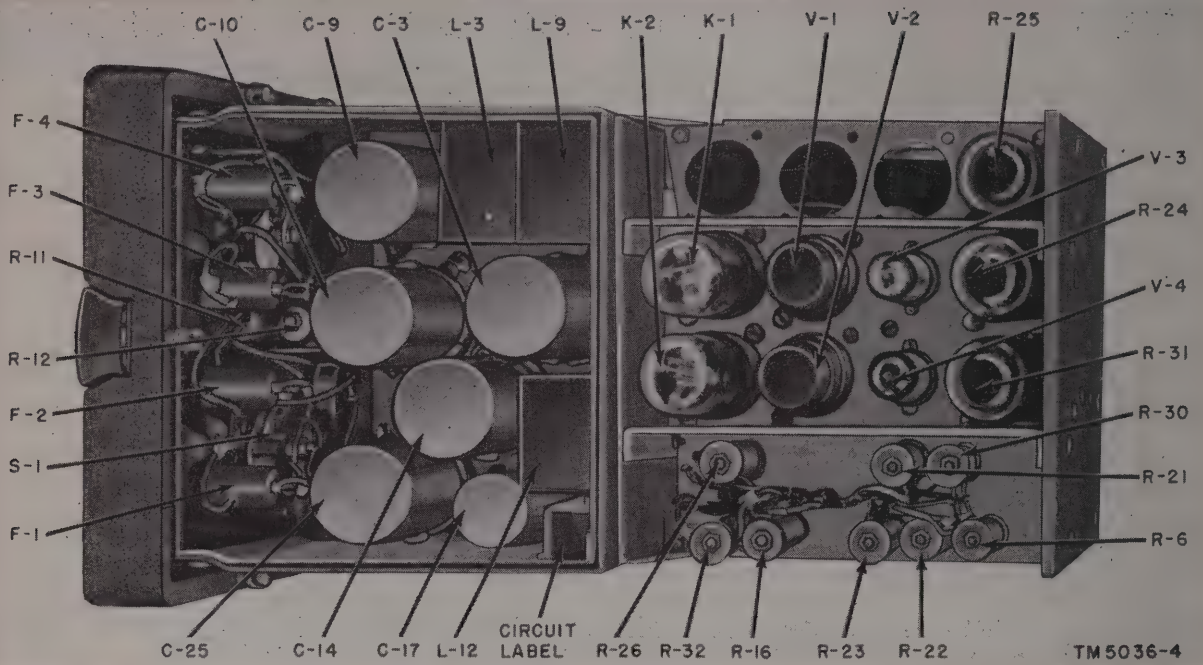


Figure 49. Power Supply PP-109/GR, top view of chassis.

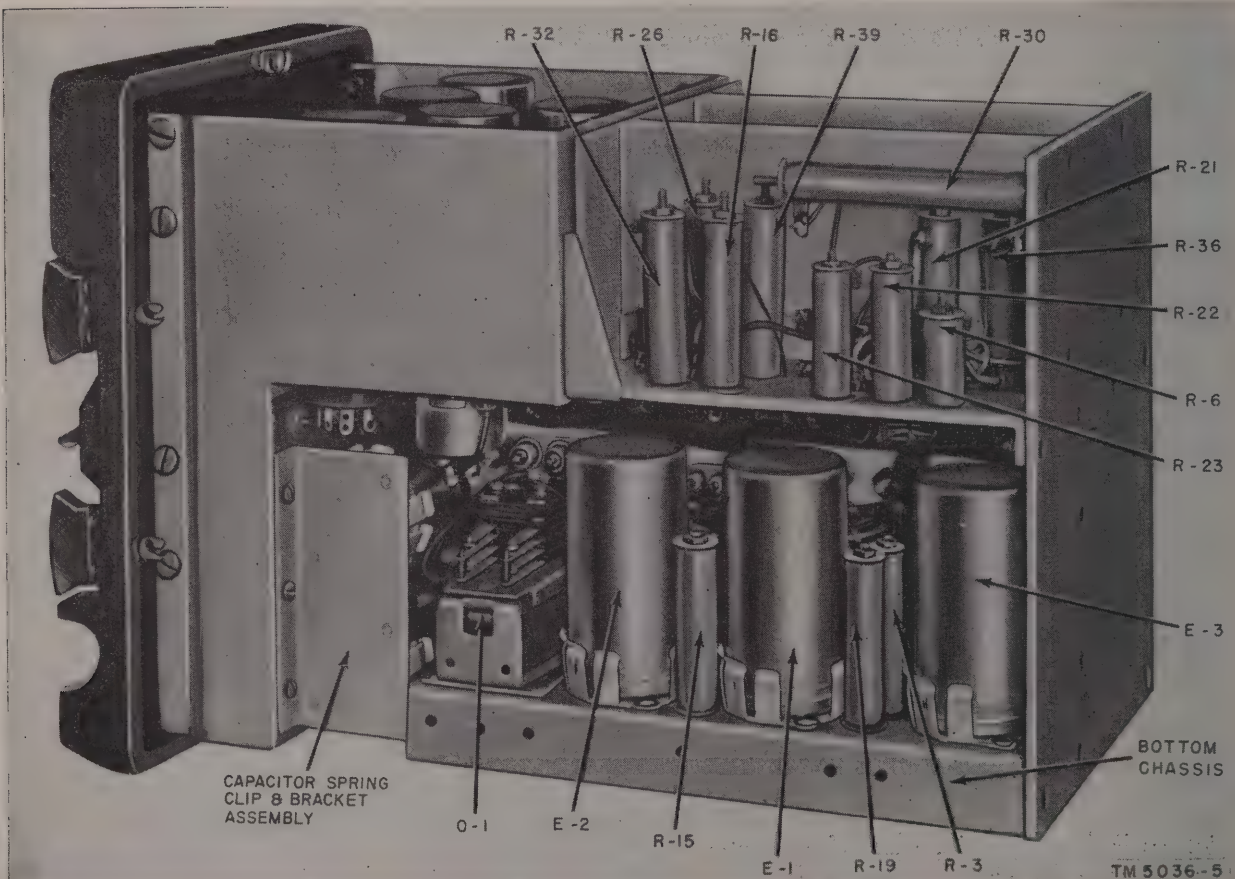


Figure 50. Power Supply PP-112/GR, right-hand side view of chassis.



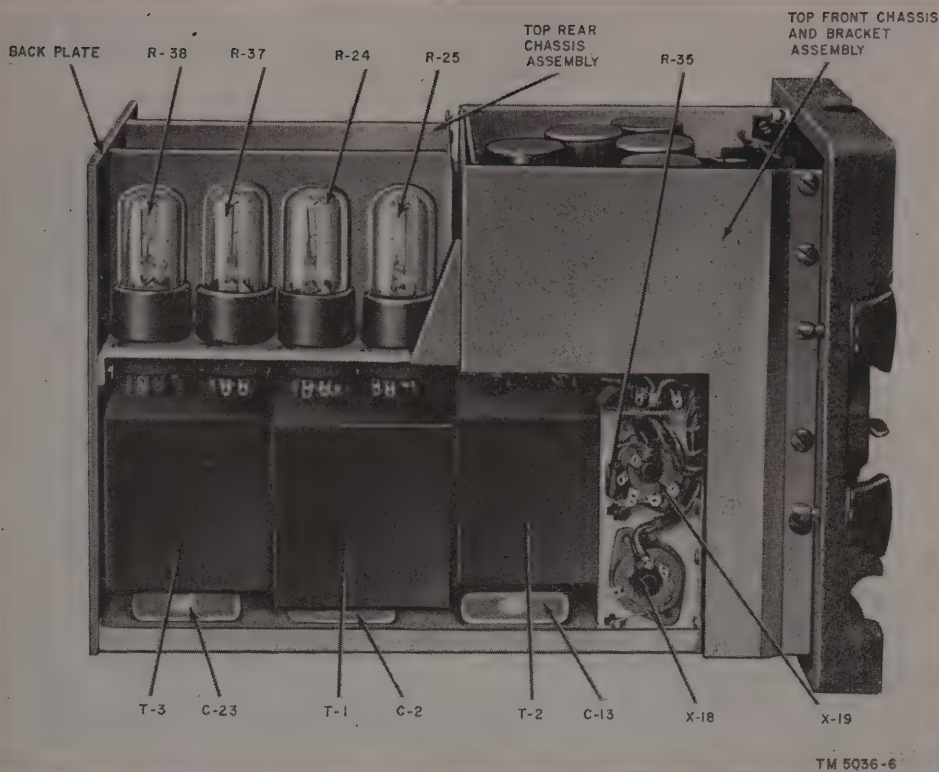


Figure 51. Power Supply PP-112/GR, left-hand side view of chassis.

*c. Tubes.* The four power supply tubes are accessible from the top of the chassis. To remove V-1 or V-2, pull the tube with a straight upward movement. To remove V-3 or V-4, use a tube puller. Do not rock or jiggle the tubes in their sockets. The socket prongs and tubes are damaged easily.

*d. Vibrators.* Three vibrators, E-1, E-2, and E-3, are located on the right-hand side of the power supply chassis (fig. 50). To remove a vibrator, pull straight upward without jiggling. If necessary, use a small screw driver to pry the vibrator from its socket. Be careful not to spread the ring clip at the base of the vibrator.

## 109. Receiver-Transmitter

The only replaceable parts in the receiver-transmitter are the tubes and lamp. These parts are mounted on the vertical r-f and i-f chassis (fig. 52). To gain access to the tubes or lamp, the panel-chassis assembly must be removed from its case (par. 106).

*a. Tubes V-1 through V-11* are mounted on the r-f chassis (fig. 55). Tubes V-101 through

V-116 are mounted on the i-f chassis (fig. 54). Each of these tubes, except V-11, may be removed with a tube puller after the shield has been removed.

*b. Before removing V-11* it is necessary to disconnect the plate cap at the top of the tube. After the cap is disconnected, the tube can be removed with a straight upward pull. Do not rock or jiggle the tube in its socket. Careless handling may damage the sockets and tubes.

## 110. Auxiliary Receiver

The replacement of pluck-out parts for which running spares are available is described in *a* through *d* below.

*a. Fuse.* The panel-mounted fuse is removed by unscrewing the fuse cap, which also serves as a fuse extractor. A spare fuse is located in a fuse clip within the receiver, at the upper right-hand side of the panel-chassis assembly.

*b. Thermal Relay and Ballast Tube.* To gain access to the thermal relay and ballast tube, remove the panel-chassis assembly from the case (par. 106). Both the relay and the ballast

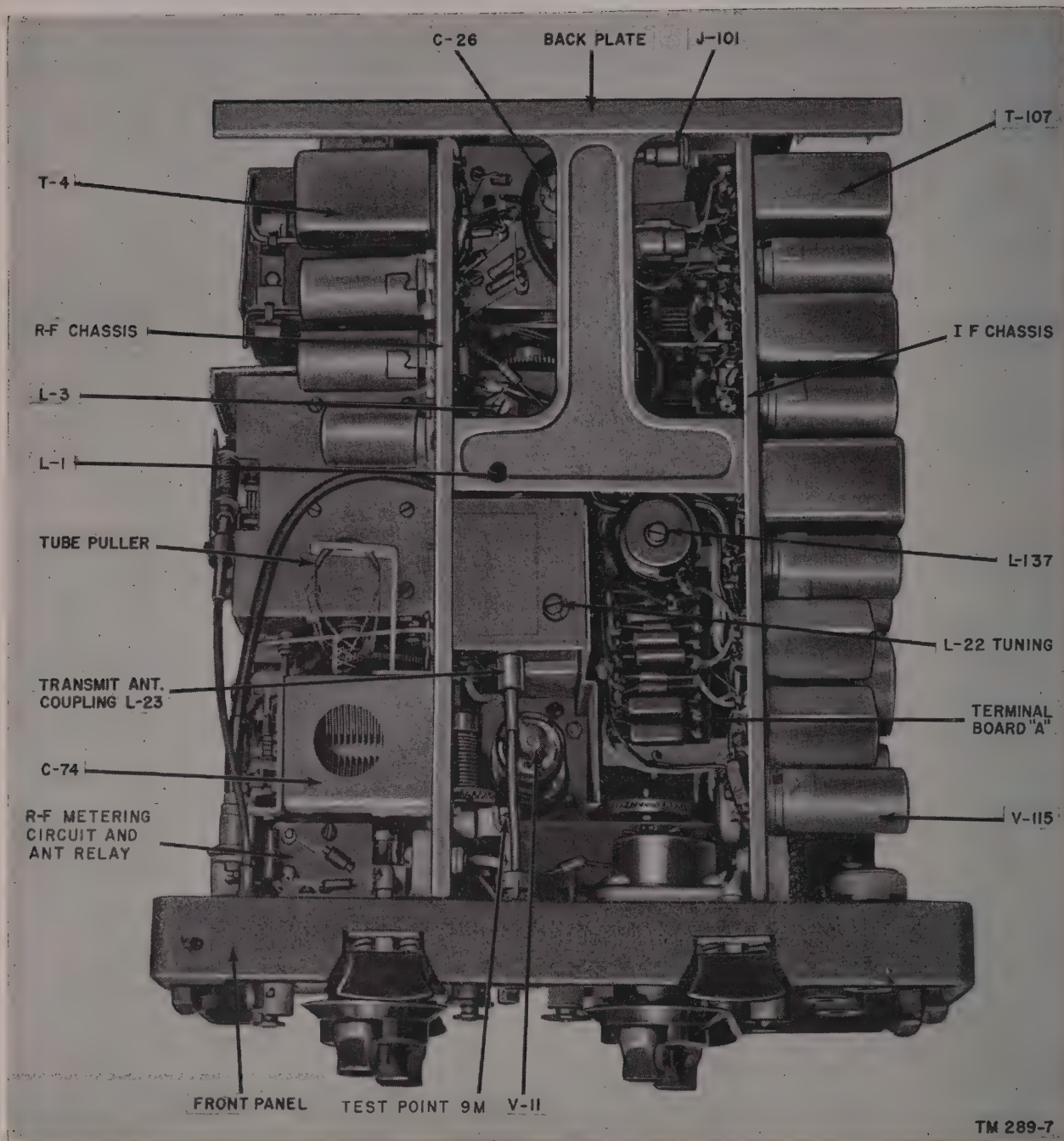
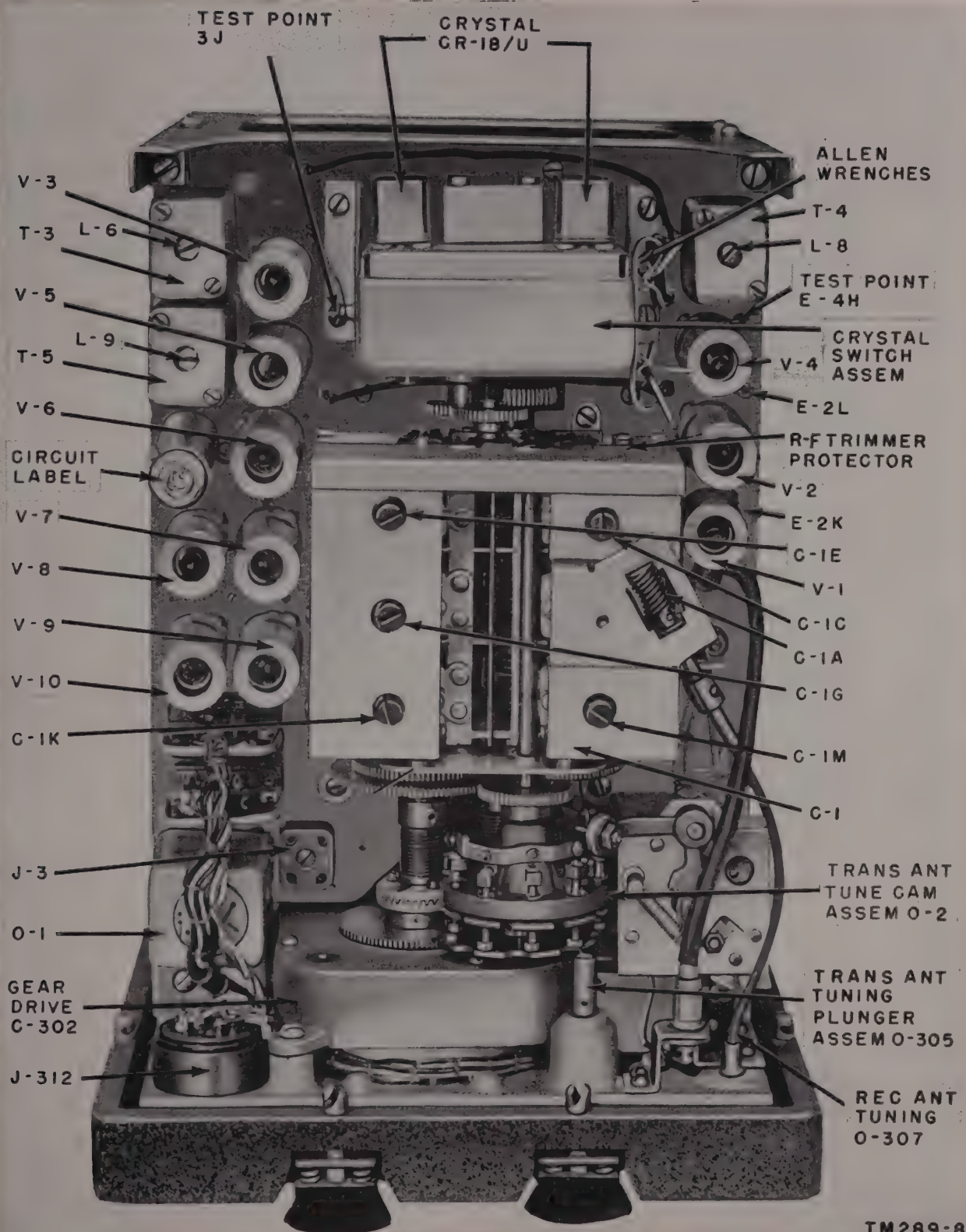


Figure 52. Receiver-transmitter panel-chassis assembly.





TM289-8

Figure 53. Receiver-transmitter r-f chassis assembly.



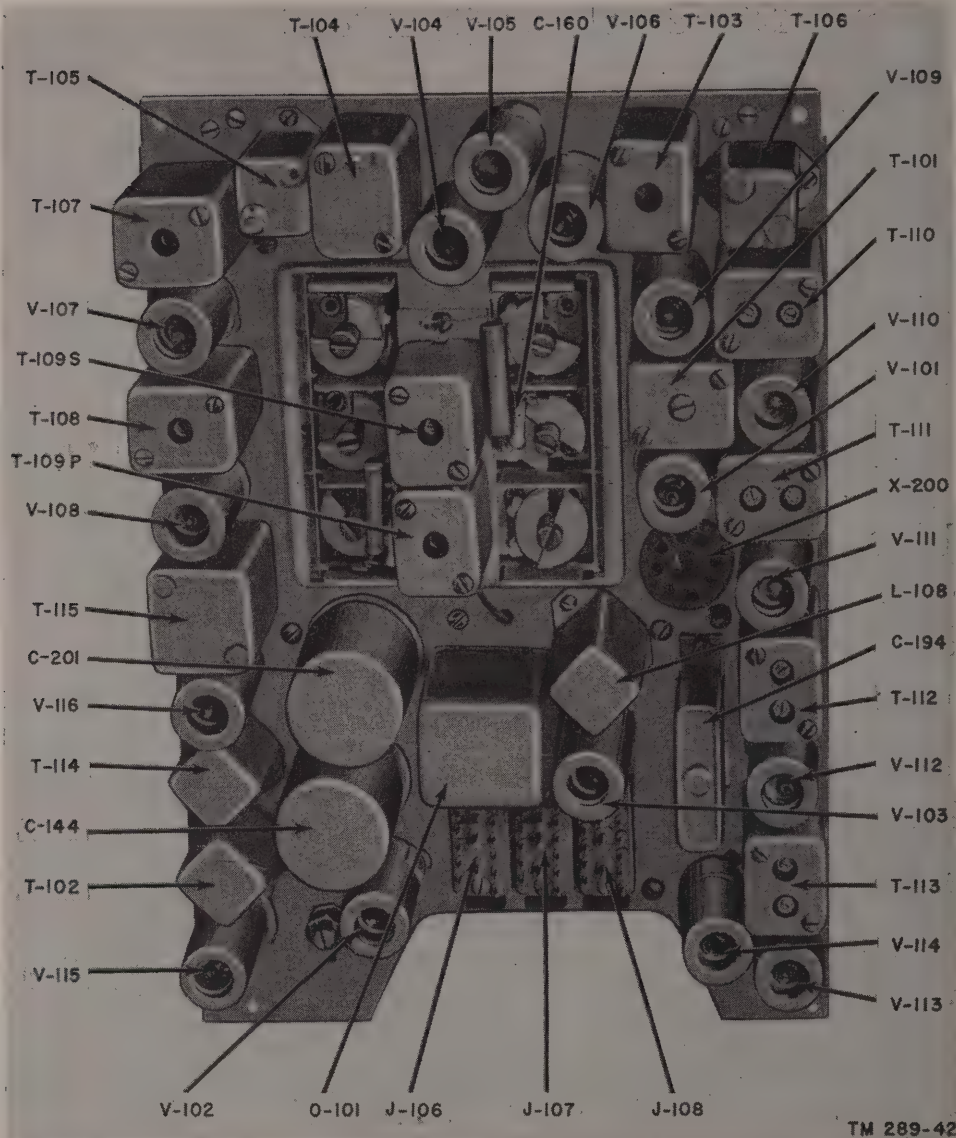


Figure 54. Receiver-transmitter i-f chassis assembly.

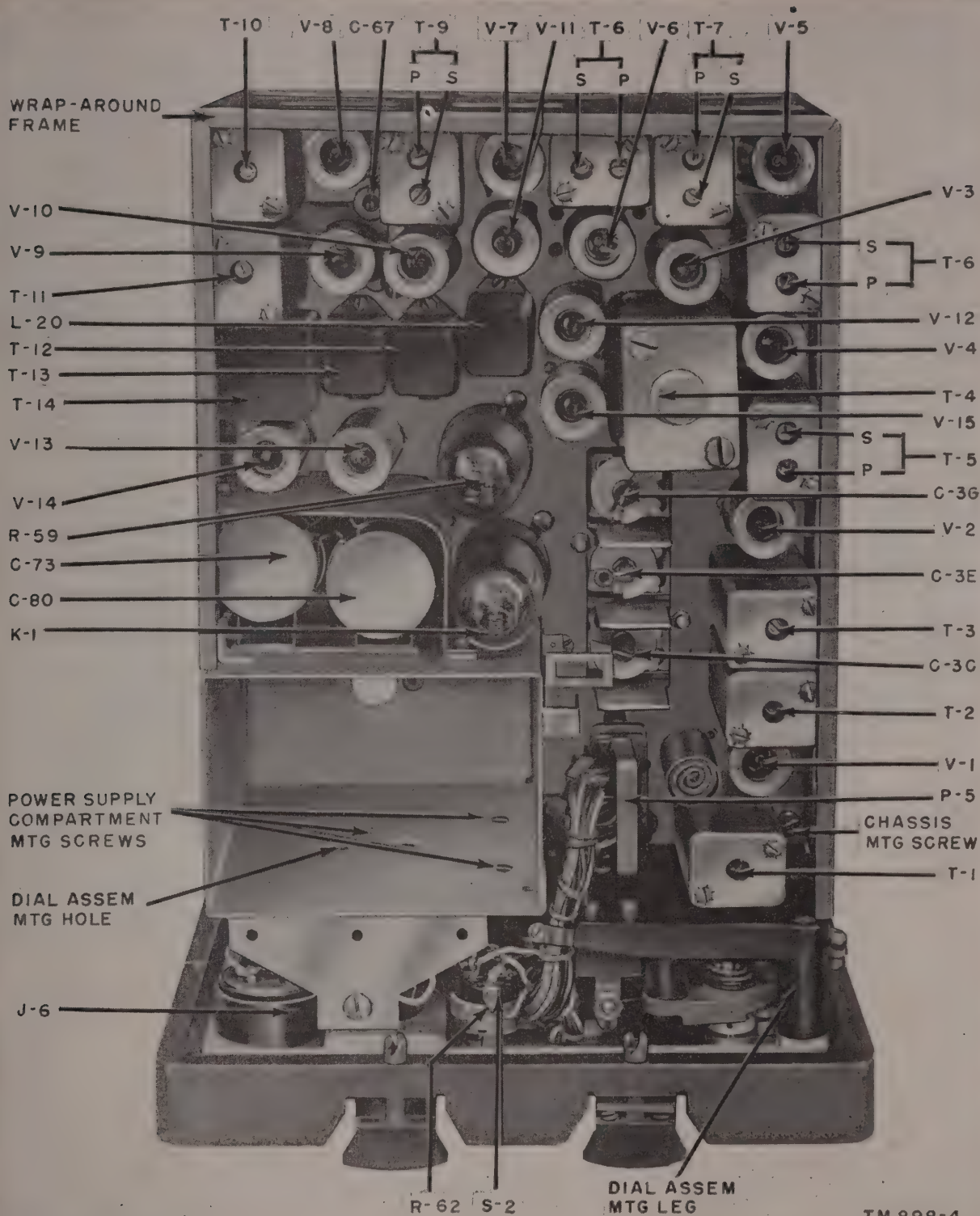
tube are located at the top of the chassis (fig. 55). Either component can be removed in the same manner as any standard octal-base tube. Pull straight upward. Do not rock or jiggle the tube in its socket.

*c. Tubes.* All the tubes are accessible from the top of the chassis when the case is removed (fig. 55). To remove any tube, first remove the shield and then use a tube puller. Do not rock or jiggle the tubes. They are damaged easily.

*d. Plug-In Power Supply.* The plug-in power supply is identical with the one used in the interphone amplifier. To replace the vibrator in this power supply, follow the procedure described in paragraph 107d.

### III. Control Box C-375/VRC

Figures 57 and 58 show two views of Control Box C-375/VRC. See appendix II for descriptions of the called out parts.



TM 898-4

Figure 55. Auxiliary receiver panel-chassis assembly, top view.

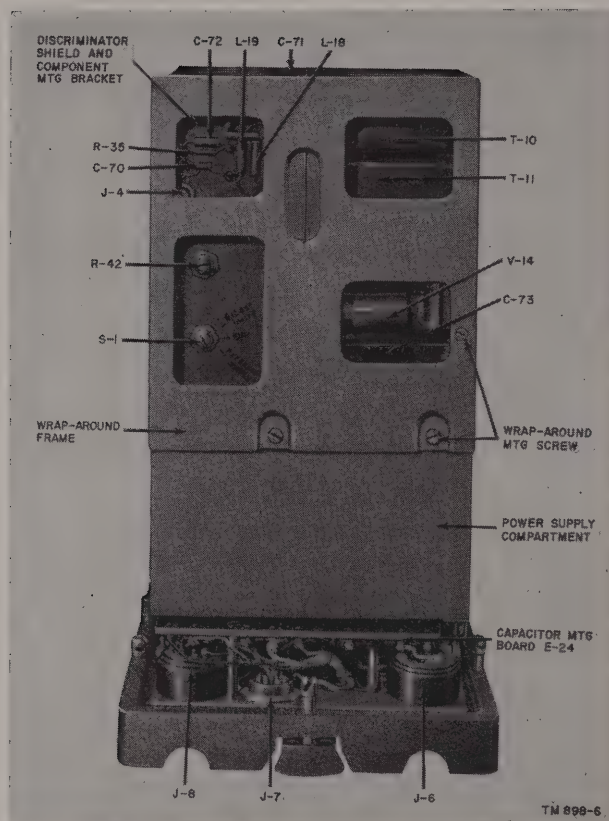
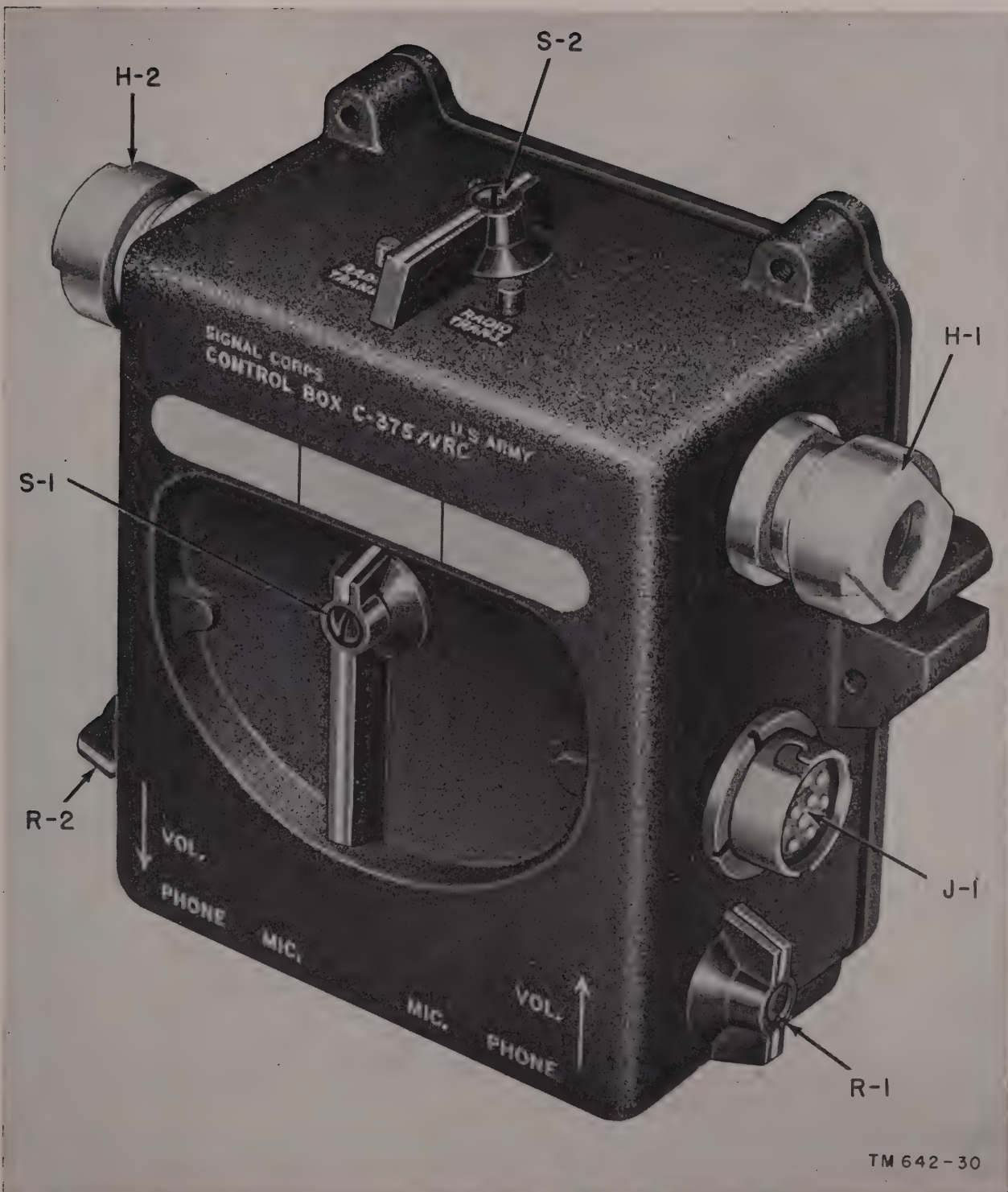


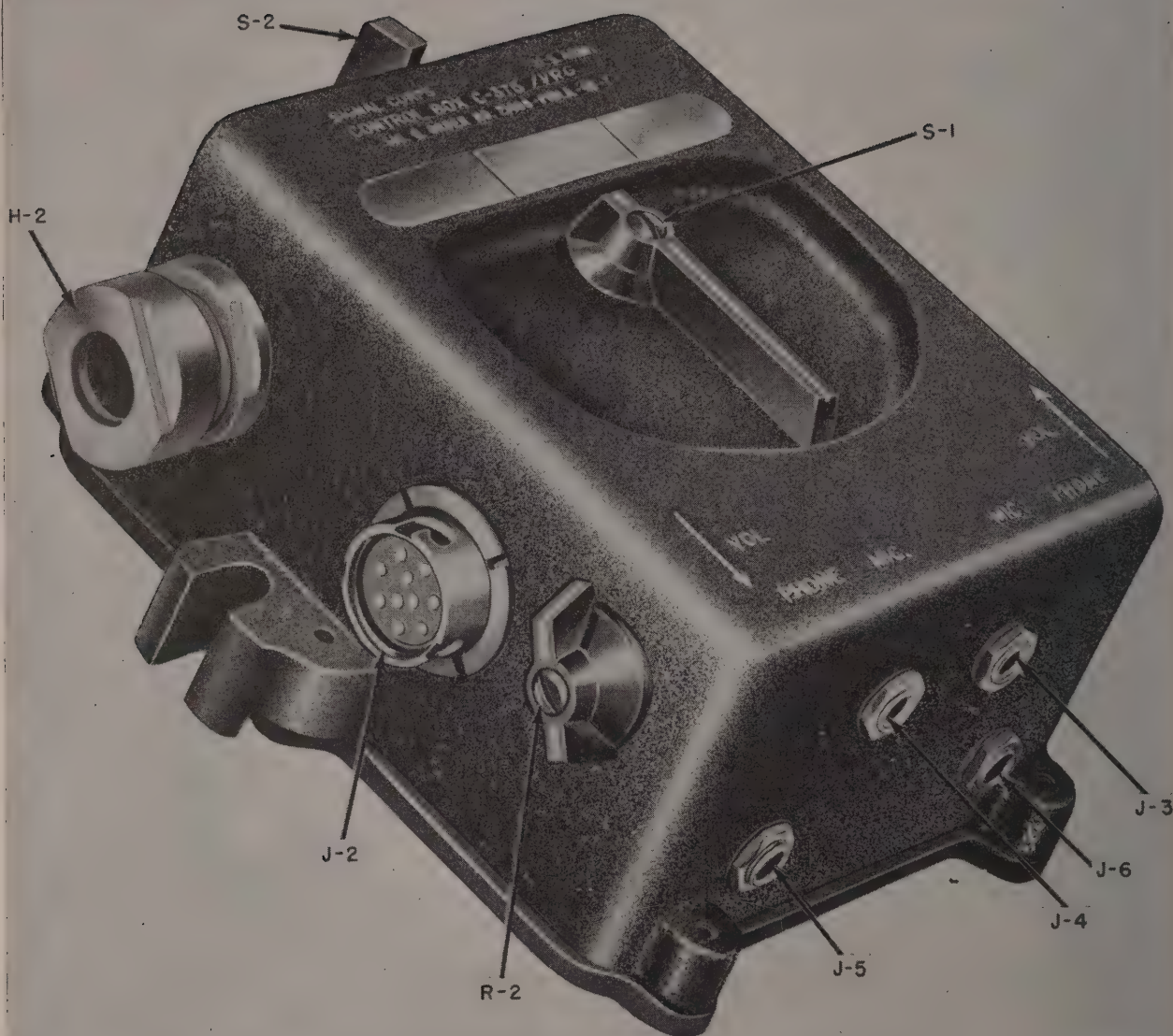
Figure 56. Auxiliary receiver panel-chassis assembly, bottom view.





TM 642-30

Figure 57. Control Box C-375/VRC, right oblique view.



TM 2643-15

Figure 58. Control Box C-375/VRC, left oblique view.



## CHAPTER 6

### AUXILIARY EQUIPMENT

#### Section I. INTRODUCTION

##### 112. Definition

Auxiliary equipment is equipment that is not supplied as part of the radio set but can be used with the set to provide additional modes of operation.

##### 113. Auxiliary Equipments Used with Radio Sets AN/VRC-20, -21, and -22

Control Group AN/GRA-6 and Modification Kit MX-898/GR can be used as auxiliary equipments with the radio set. In this chapter, installation and operating instructions for these equipments are provided.

*a.* Control Group AN/GRA-6 provides for

local and remote control of the radio set as well as duplex telephone facilities. The system theory relating this equipment to Radio Sets AN/VRC-20, -21, and -22 is described in chapter 4. For detailed information pertaining to theory and maintenance, see TM 11-5038.

*b.* Modification Kit MX-898/GR contains a hand generator and a battery which enable the receiver-transmitter to be operated in the field away from a vehicular storage battery. When Control Group AN/GRA-6 is used with this equipment, remote push-to-talk operation with local power control is possible.

*Note.* No modifications are necessary in the receiver-transmitter in order to use it with this equipment.

#### Section II. CONTROL GROUP AN/GRA-6

##### 114. Purpose and Use

Control Group AN/GRA-6 (fig. 59) may be used to provide local or remote monitoring, push-to-talk facilities, and remote control of power for the radio sets. Provisions for two-way telephone communications and ringing between the remote and local control operators are provided. The control group includes Local Control C-434/GRC, Remote Control C-433/GRC, and Handset H-33/PT with its cable connector plug and push-to-talk switch. In addition, Bag CW-189/GR is provided as a carrying or storing container. Connection between the local and remote control positions is provided by a pair of telephone wires, not supplied as part of this equipment. Complete information on the control group is contained in TM 11-5038.

##### 115. Local Control C-434/GRC

*a.* The local control unit is a compact, lightweight panel-chassis assembly with an immersionproof case. The outer case is held to the panel by means of two wing-type thumbscrews.

Channel rails are fitted to the sides of the case to permit mounting the unit in the space provided for this purpose on the mounting. The connector at the rear of the control unit (fig. 61) plugs into a mating connector on the mounting, establishing a connection between the control unit and the radio sets installed on the mounting.

*b.* The local control also may be connected directly to the panel of the receiver-transmitter by means of plug-terminated cords at the rear of the unit (fig. 61).

*c.* In either case, the switching facilities of the unit allow for monitoring and push-to-talk transmission from a handset or chest set plugged into the AUDIO receptacle on its front panel.

##### 116. Remote Control C-433/GRC

*a.* The remote control unit is a compact, lightweight panel-chassis assembly with an immersionproof outer case. The case is secured to the panel by means of two snap catches. The unit may be carried by a shoulder strap pro-





TM 5038-1

Figure 59. Control Group AN/GRA-6.

vided for the purpose. Rings on the sides of the panel are provided for engaging the strap.

b. The remote control may be as much as 2 miles distant from the local unit. A telephone line is used to interconnect the two units. The combined switching actions of the two units make it possible to extend both power control and push-to-talk facilities to the remote unit. The remote unit accommodates a handset or a chest set.

#### 117. Handset H-33/PT

The handset includes a 40-ohm carbon-type microphone, a 300-ohm earpiece, a nonlocking push-to-talk switch, and a 5-foot cord terminating on a 10-pin connector. This connector mates with any of the AUDIO connectors on the various units. The push-to-talk switch is a DPST (double-pole, single-throw) switch which closes when the rubber-covered bar on the side of the handset is depressed.

#### 118. Bag CW-189/GR

This bag is a dustproof and waterproof canvas container provided for storing and carrying

purposes. It is equipped with a carrying strap. The units may be stored in the bag when not in use or when being transported.

#### 119. Installation of Control Group AN/GRA-6

An initial installation of the control group should be made to determine that the equipment will operate properly. Make this initial installation in accordance with the instructions in the following paragraphs, after the major components of the system have been installed, tuned, and checked. Turn the power switch on the mounting to OFF before beginning the installation.

#### 120. Installation of Batteries in Local Control C-434/GRC

Prepare this unit for installation as follows:

a. Loosen the thumbscrew fasteners on the panel of Local Control C-434/GRC and remove the panel-chassis assembly from the case.

b. To install the batteries, place the panel-chassis assembly bottom side up and release the catch holding the battery compartment cov-

er in place. Remove the cover (fig. 60).

c. Install one battery so that the outer metal case rests on the spring on the floor of the container.

d. Install the other battery so that its base faces upward, and the center electrode (the positive terminal) rests against the flat battery contact on the floor of the compartment.

e. Replace the compartment cover, making sure that the batteries make proper connection with the contacts on the cover and within the compartment.

f. Set the BELL-LAMP switch, mounted on a bracket attached to the panel-chassis assembly, in the BELL position if an audible indication of the ringing signal is desired, or to the LAMP position if a visual ringing signal indication is desired.

g. Replace the panel-chassis assembly in the case and tighten the screw fasteners.

## 121. Installation of Local Control C-434/GRC

The local control unit may be plugged directly into the mounting by means of connector J-2, or it may be connected to the panel of the

receiver-transmitter by means of the Set 1 connecting cable located in the cable compartment of this unit (fig. 61). (When this latter method of connection is used, remote power control of the radio set is impossible.) Plugging the local control unit directly into the mounting is the most convenient method. This method should be used with Radio Sets AN/VRC-20, -21, and -22. Both methods are described below.

### a. Direct Connection to Mounting.

- (1) Remove the protective cover plate from the large plug (J-2) at the rear of the unit (fig. 61).
- (2) Open the cable compartment by pressing the snap catch at the rear of the unit. Snap the cover plate in place in the cap retaining brackets on the inside of the storage compartment. Close the cable compartment cover.
- (3) Slide the control unit by its runners into the mounting as far back as possible. Then lock the unit in place by means of the locking lever on the mounting.

### b. Connection by Cables (Alternate Method).

- (1) Open the storage compartment by

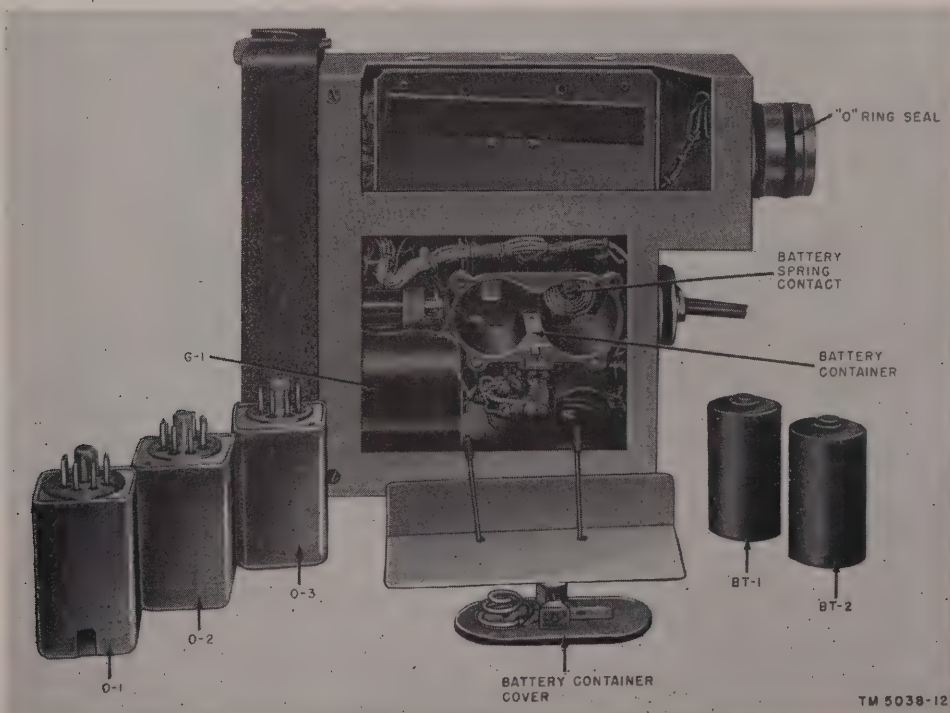


Figure 60. Local Control C-434/GRC, bottom view of chassis.



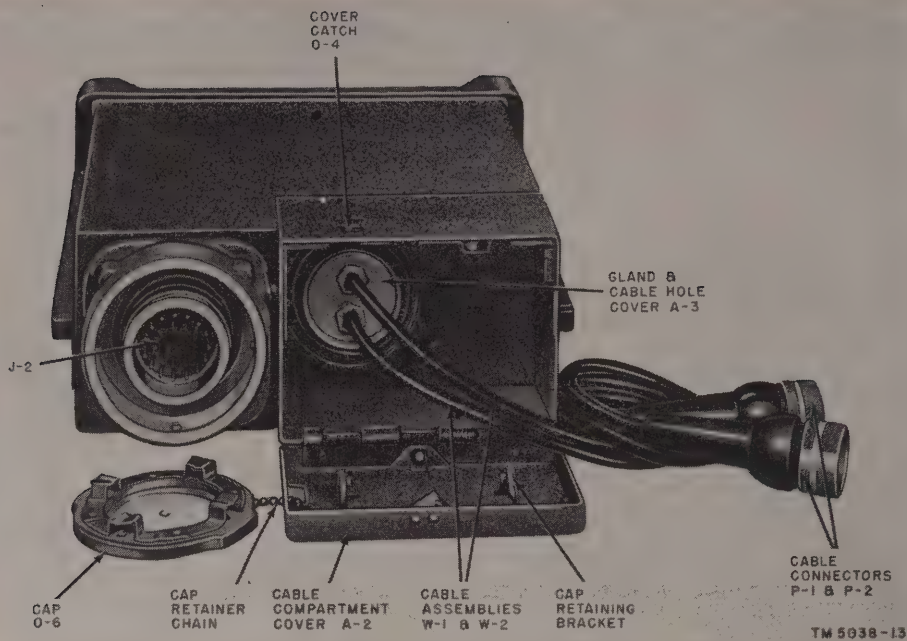


Figure 61. Local Control C-434/GRC, rear view.

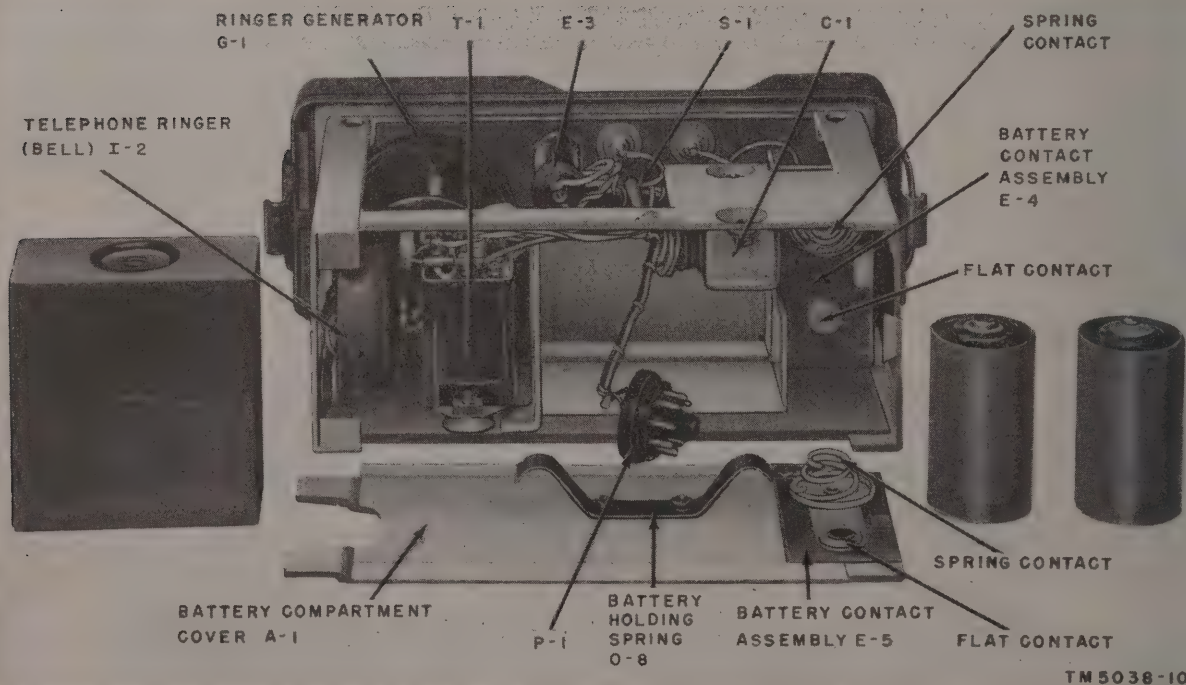


Figure 62. Remote Control C-433/GRC, rear view of chassis.



pressing the snap catch at the rear of the unit (fig. 61). Extend the two cables that are located within this compartment.

- (2) Attach the cable marked SET 1 to the AUDIO connector on the receiver-transmitter. Return the other cable to the compartment.

## 122. Installation of Remote Control C-433/GRC

The remote control is intended for portable use. Prepare this unit for installation as follows:

a. Set the panel-mounted SELECTOR switch to the TEL position (fig. 64).

b. Release the two snap catches that hold the outer case to the panel-chassis assembly, and remove the unit from the case.

c. Remove the tape which secures the battery compartment cover to the sides of the unit, and remove the cover. To do this, slide the cover back slightly to clear the tab on one side; then lift off the cover.

d. Install two 1½-volt Batteries BA-30 in the compartment provided for them in the left rear of the chassis frame (fig. 62). Install one battery in the compartment so that the bottom of the battery outer case (negative electrode) rests over the spring contact on the battery compartment floor. Install the second battery so that the center post (positive electrode) of the battery rests on the flat contact of the battery compartment floor.

e. Insert 45-volt Battery BA-414/U into the large battery compartment in the chassis frame, so that the octal socket on the battery faces upward (toward the rear of the unit).

f. Insert the octal male plug P-1 at the end of the battery cable into the battery socket. Do not twist the battery cord excessively.

g. Replace the battery compartment cover by inserting the two projections at one edge of the cover under the bracket angles on the side of the chassis. Press the cover down and slide it forward until the lip (or tab) at the other edge of the chassis frame slides over the corresponding notch in the cover. Release the pressure, and check to see that the tab is locked properly and that the batteries are positioned properly.

h. Set the internal BELL-LAMP switch (S-

1) to the BELL position (fig. 62) if audible indication of the ringing signal is desired. Set this switch to the LAMP position if a visual indication of the ringing signal is desired.

i. See that pilot lamp E-3 is installed in its holder. The pilot lamp is accessible from the rear of the panel by pulling the lamp socket out of its holder. Pull straight toward the rear of the unit.

j. Restore the panel-chassis assembly in the case and fasten it to the panel by the snap catches.

k. Attach the carrying strap (stored in Bag CW-189/GR) to the D rings on the outer case of the unit.

## 123. Interconnections

a. Interconnect Local Control C-434/GRC and Remote Control C-433/GRC over the distance required (up to 2 miles). Wire WD-1/-TT, Wire W-110-B, or an equivalent 2-wire telephone line may be used for the interconnection. Strip the insulation from the ends, and tin the bared wires before clamping them in the binding posts (designated L-1 and L-2) on each of the units.

b. Similarly designated posts (L-1 to L-1 and L-2 to L-2) should be interconnected. Make a continuity check to insure proper connections.

## 124. Installation of Audio Accessories

a. Handset H-33/PT normally is used at the remote unit. Install the handset on either unit by attaching the connector plug at the end of the handset cord to the AUDIO receptacle on the control unit. Do this by lining up the flats of the cable connector and the flat part of the panel-mounted audio receptacles. Then rotate the cable connector clockwise to lock it in place. A clip provided on the handset permits attaching it to the pocket or belt of the operator, the rim of the front panel of a control unit, or the carrying strap of the remote unit when not in use. A second handset may be used at the other control unit. Attach it to the AUDIO connector of that unit as described above.

b. Chest Set Group AN/GSA-6 with Headset-Microphone H-63/U can be used at the local control unit as an alternate (par. 18b and c). If the chest set is used, lock the RADIO-

INT switch in the RADIO position by the internal lock (fig. 28). Connect the cable from the chest set to the AUDIO receptacle on the control unit, and connect the cables from Headset-Microphone H-63/U to the appropriate receptacle on the chest set. (Usually, only one audio accessory is provided for each control group.)

## 125. Operational Check

Perform the preliminary starting procedure (pars. 57 through 60) and steps 41 through 69 of the equipment performance checklist (par. 94c).

## 126. Operation from Audio Receptacle (Alternate Method)

a. When satisfactory performance has been assured, turn the power switch on the mounting to OFF and remove the local control from the mounting.

b. Replace the protective cover on the plug at the rear of the local unit (fig. 61), and con-

nect the Set 1 cable to one of the AUDIO receptacles on Set 1.

c. Return the power switch of the mounting to ON. Perform the operations in items 41 through 69 of the equipment performance checklist (par. 94c).

## 127. Disassembly Procedure

a. When satisfactory performance has been assured, disconnect the local unit from Set 1.

b. Disconnect the telephone wire from the local and remote units.

c. Remove the batteries from the two units. Do not leave the batteries installed unless the units will be used within 24 hours.

## 128. Storage

When Control Group AN/GRA-6 is not required for operation, store it in Bag CW-189/-GR. When the control group is used, this bag can be used for storing audio accessories or other small items.

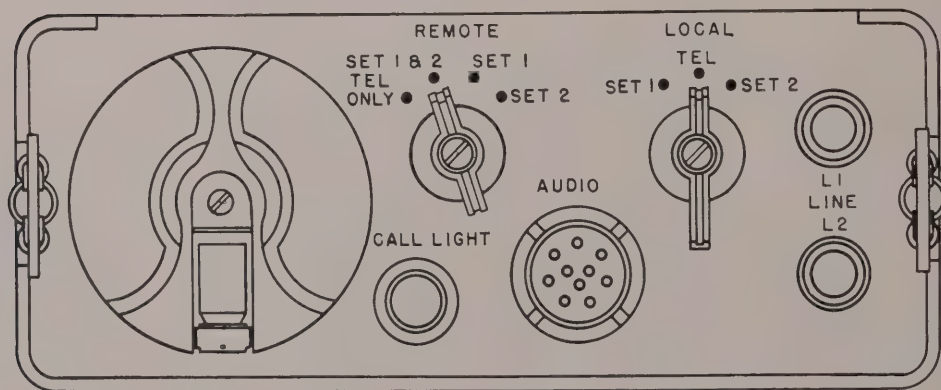


Figure 63. Panel view of local control unit.

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129. Controls on Local Control C-434/GRC

Figure 63 illustrates the layout of controls and connectors on Local Control C-434/GRC. The controls and their functions are described in the following chart:

Control or connector	Function
LOCAL switch (S-3)	Provides for push-to-talk operation of Set 1 and for duplex telephone operation with the remote unit. SET 1 position: Allows push-to-talk operation of Set 1 from the local control unit. SET 2 position: Not used in Radio Sets AN/VRC-20, -21, and -22. TEL position: Allows telephone operation and radio monitoring at the remote unit. (Monitoring circuit is broken if REMOTE switch is at TEL ONLY position.)
REMOTE switch (S-1)	In conjunction with controls at remote unit, provides for remote control of power of the radio set and/or remote control of push-to-talk operation of Set 1. Also provides means of limiting operation (at the remote unit) to telephone communication. TEL ONLY position: Allows for telephone communication between local and remote control units. SET 1 & 2 position: Provides for remote push-to-talk operation of Set 1. Keeps power on in

Control or connector	Function
LINE L1 and L2	radio set when power switch on mounting is at REMOTE position.
Ringings generator	SET 1 position: Provides for remote control of power for the radio set and push-to-talk operation of Set. 1.
CALL LIGHT (E-3)	SET 2 position: Not used in Radio Sets AN/VRC-20, -21, and -22.
AUDIO receptacle (J-1)	Binding posts for telephone line connections.
O-ring connector (J-2)	Provides means of sending 20-cycle ringing signal to the remote unit.
Cable connector (P-1) (P-2 is not used on Radio Sets AN/VRC - 20, -21, and -22).	When lighted, indicates that a ringing signal is being received from the remote unit. (CALL LIGHT indication can be replaced by a bell, by means of an internal switch.) Dimmer control provides for masking the glow of the lamp.
	Provides means of connecting a chest set (with headset and microphone) for telephone communication and push-to-talk operation of the radio set.
	Serves as an interconnection for signal, receive-transmit control, and power circuits from the mounting to the control group, when the local control is plugged into the mounting.
	Serves to connect the circuits of the control group to one of the panel-mounted AUDIO receptacles on Set 1.

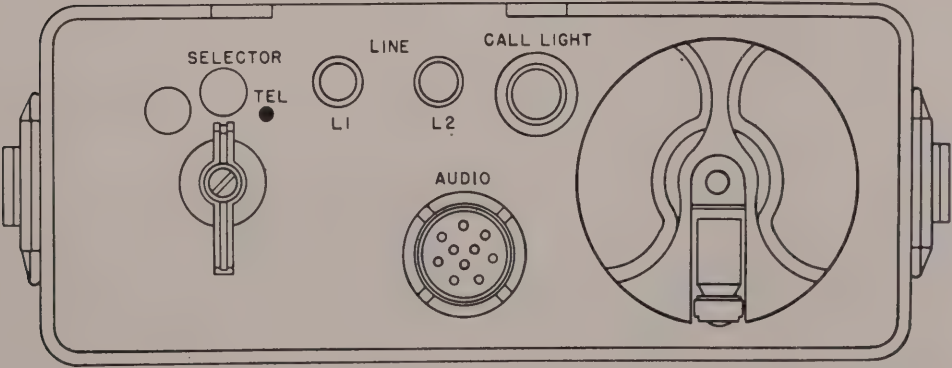


Figure 64. Panel view of remote control unit.

TM 5038-16



### 130. Controls on Remote Control C-433/GRC

Figure 64 illustrates the controls and connectors on Remote Control C-433/GRC. The controls and their functions are described in the following chart:

Control or connector	Function
SELECTOR switch	In conjunction with controls at local unit, provides for remote control of power for the radio set and/or push-to-talk operation of Set 1; also provides means of limiting operation to telephone communication. Left-hand write-in position: A power-on position and/or Set 1 remote control position, depending on setting of REMOTE switch in local control unit. Right-hand write-in position: A power-off position for Set 1, depending on setting of REMOTE switch in local control unit. <sup>1</sup>
LINE L1 and L2	TEL position: Limits operation to telephone communication between local and remote units. Binding posts for telephone line connections.
Ringing generator	Provides means of sending a 20-cycle ringing signal to the local control unit.
CALL LIGHT (E-3)	When lighted, indicates that a ringing signal is being received from the local unit. (CALL LIGHT indication can be replaced by a bell by means of an internal switch.) Dimmer control provides for masking the glow of the lamp.
AUDIO receptacle (J-1)	Provides means of connecting a handset for telephone communication and push-to-talk operation of the radio set.

<sup>1</sup>The functions of the write-in positions are reversed by the reversal of the telephone-line connections at either the local or remote control units.

### 131. Modes of Operation

Although Control Group AN/GRA-6 is provided mainly to allow remote operation of the radio sets from points up to 2 miles away from the installation, local as well as remote operating facilities are available. The complete

facilities are as follows:

- Simultaneous monitoring of all received signals at both local and remote units.
- Local push-to-talk operation and power control Set of 1.
- Duplex telephone communication, including ringing, between local and remote units.
- Remote push-to-talk operation and power control of Set 1.

### 132. Preliminary Adjustments

Turn the OFF-REMOTE-ON switch of the mounting to OFF and install Control Group AN/GRA-6 as described in paragraphs 120 through 124. When the installation is completed, set the power switch on the mounting to ON, make the squelch and volume-level adjustments on Set 1, and select the operating frequencies as described in paragraphs 53 and 56. Leave the OFF-REMOTE-ON switch at ON except as directed for remote power control in paragraph 137.

### 133. Monitoring

To monitor the output of the receivers at both the local and remote control units, leave the LOCAL switch at TEL and set the REMOTE switch of the local unit at any position except TEL ONLY.

### 134. Local Push-to-talk Operation

- Set the REMOTE switch to SET 1.
- For push-to-talk operation of Set 1, hold the LOCAL switch in the SET 1 position, press the push-to-talk switch on the chest set, and talk into the microphone. Release the LOCAL switch to listen.

*Note.* Lock the RADIO-INT switch on the chest set in the RADIO position by means of the internal adjustment. This allows more convenient operation.

### 135. Duplex Telephone Operation

For normal telephone communication between local and remote units, set the REMOTE switch of the local unit in the TEL ONLY position, and set the SELECTOR switch of the remote unit in the TEL position. (These are the normal positions of the switches when push-to-talk operation is not desired.)

- To send a ringing signal in either direction, turn the crank of the ringing generator

in the sending unit (local or remote). Either a CALL LIGHT will glow or a bell will ring at the receiving end, depending on the setting of internal switches in the local and remote units.

*Note.* A ringing signal should not be sent at any time in either direction unless the LOCAL and REMOTE switches at the local unit are at TEL and TEL ONLY, respectively, and the SELECTOR switch at the remote unit is at TEL. Otherwise this signal may go out over the transmitter.

b. To communicate, press the push-to-talk switch on the handset (at the remote unit) or the push-to-talk switch on the chest set (at the local unit) and talk into the mouthpiece or microphone. Full duplex telephone operation is possible. Release the push-to-talk switch while listening to conserve the life of the battery.

### 136. Local Power Control and Remote Push-to-talk Operation

a. Set the OFF-REMOTE-ON switch (on mounting) at ON.

b. On the local control unit, set the REMOTE switch at SET 1.

c. On the remote control unit, set the SELECTOR switch at the left-hand write-in position.

d. At the remote control unit, press the push-to-talk switch to transmit; release to listen.

*Note.* If the telephone line connections at either unit are reversed, the right-hand write-in position will control Set 1.

### 137. Remote Power Control and Push-to-talk Operation

a. Set the OFF-REMOTE-ON switch (on the mounting) at REMOTE.

b. Set the REMOTE switch of the local control unit in the SET 1 position.

c. Set the SELECTOR switch of the remote control unit in the left-hand write-in position. Press the push-to-talk switch on the handset momentarily; this applies power to the radio set.

d. After power is applied, press the push-to-talk switch to transmit; release to receive.

e. To turn off power on the radio set, turn the SELECTOR switch to the other (right-hand) write-in position and press the push-to-talk switch momentarily.

*Note.* The use of the left-hand write-in position as an *on* position and the right-hand write-in position as an *off* position is chosen for convenience. If the telephone line is reversed, the functions of the switch positions are reversed.

## Section III. MODIFICATION KIT MX-898/GR

### 138. Purpose and Use

Modification Kit MX-898/GR provides the components necessary for temporary operation of an individual receiver-transmitter when it is transferred from a vehicle to a field location, or when vehicular power is not available. If Control Group AN/GRA-6 is used with the auxiliary equipment, remote as well as local operation of the receiver-transmitter is possible in a field installation.

### 139. Components

The components of Modification Kit MX-898/GR are listed and are described briefly in the following subparagraphs:

a. *Generator G-8/GRC* (fig. 65).

(1) Generator G-8/GRC is a hand-operated source of power. It is a three-commutator generator with an actu-

ating geartrain, radio-noise filter, and voltage regulator. The components are shock-mounted inside a waterproof, cast-magnesium case. The outside of the case contains openings for the operating cranks, the power connector, and the necessary straps for attachment to the mounting legs.

(2) The generator is capable of supplying all the voltages required for operation of receiver-transmitter when the hand crank is rotated at a rate of 50 to 70 rpm (revolutions per minute). The power output (85 watts) at the above speed is slightly lower than that delivered by the vehicular power supplies normally used as power sources. High voltages (400, 250, and 145 volts) and bias voltage (-30 volts) are obtained from one of the three





Figure 65. Generator G-8/GRC.

independent armature windings. A second winding provides a medium voltage output (90 volts) and a third

winding provides a 1-v output (6.3 volts).

- (3) The crank of the generator is rotated by a single operator seated on the seat leg (fig. 65). The generator should not be operated unless properly connected to the receiver-transmitter, either directly to the receiver-transmitter panel or through the battery box (Case CY-590/GRC) (fig. 70 or 71). See TM 11-5037 for detailed information on the generator.

b. Case CY-590/GRC (fig. 66).

- (1) Case CY-590/GRC is a metal battery box which is used to power the receiver of Set 1. This enables the operator who cranks the hand generator to rest during receiving periods. The facilities provided by the various installations are given in the chart in paragraph 140.
- (2) The battery box contains five series-connected 1.5-volt batteries (BA-403/U) and one 90-volt battery (BA-419/U) which are held by a tray fastened to the case panel (fig. 69). To reach the battery tray, loosen the Dzus fasteners which connect the panel to the case. Slide the panel-tray assembly from the case (fig. 68).

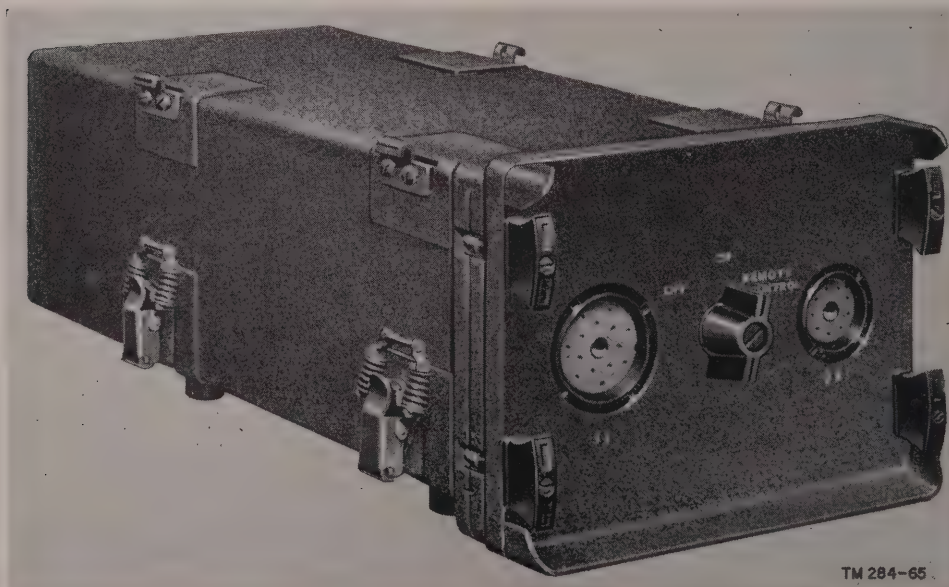


Figure 66. Case CY-590/GRC, front view.



(3) Two receptacles and a switch are provided on the front panel of the battery box (fig. 67). The receptacles are used for interconnecting the battery box with the receiver-transmitter and the hand generator. The OFF-ON-REMOTE CONTROL switch makes or breaks the battery circuits to the receiver-transmitter.

c. *Power Cable Assembly CX-1209/U*. This cable, one of the two supplied with Modification Kit MX-898/GR, is used in a field installation of the receiver-transmitter which uses both Generator G-8/GRC and Case CY-590/-GRC. The cable contains a 9-pin and a 14-pin male plug. The 9-pin plug mates with the receptacle of the battery box; the 14-pin plug, with the receptacle of the generator.

d. *Power Cable Assembly CX-1210/U*. This cable is used in all field installations of the receiver-transmitter. The cable contains two 14-pin male plugs. In field installations of the receiver-transmitter, one of the plugs is connected to the POWER IN receptacle of Set 1. The other plug is connected to the 14-terminal receptacle on the battery box (or on the generator if the battery box is not used). This cable is wired symmetrically so that either end may be plugged into either unit.

e. *Mounting MT-652/GR*. Mounting MT-652/GR holds the antenna masts used in field installations. A raised section of the overhanging flange of the receiver-transmitter panel contains a socket which fits the base of Mounting MT-652/GR. The base is held by a pin within the socket which engages a Dzus fastener slot on the bottom of the mounting. Two sockets are provided at right angles to allow alternate methods of securing the mast, depending on the more convenient position for the receiver-transmitter (right-side up or panel-up). When the mounting is secured, the mast sections supplied with the modification kit can be screwed into the mounting. A rubber-covered lead-in wire, which is part of the mounting, connects the antenna to the ANT post on the receiver-transmitter.

f. *Handset H-33/PT*. Handset H-33/PT normally is used as the audio device of the receiver-transmitter. A cord, permanently attached to the handset, is terminated by a multi-connector which connects to the AUDIO recep-

tacle on the receiver-transmitter. A detailed description of the handset is given in paragraph 18e.

g. *Mast Sections AB-22/GR, AB-23/GR, and AB-24/GR*. These antenna sections in various combinations, depending on the units being used, fit into Mounting MT-652/GR for field operation. The sections consist of copper-plated chrome-molybdenum steel tubes covered with a lusterless olive drab enamel. Each section is approximately 23 inches long and can fit into any of the other sections.

h. *Bag CW-187/GR*. Canvas Bag CW-187/-GR is supplied with the modification kit to accommodate the handset, antenna mounting, mast sections, cables, generator legs, and the technical manuals supplied with the generator. Web straps are provided for closing and carrying the bag.

i. *Bag CW-188/GR*. Two canvas Bags CW-188/GR generally are supplied with each kit. One bag is used to carry the battery case and hand generator; the other, a receiver-transmitter.

## 140. Applications

a. The following chart lists the operational applications of the modification kit with the receiver-transmitter:

Unit	Components	Cables required	Facilities
Set 1	Generator and battery box.*	CX-1209/U and CX-1210/U.	Transmit and receive.
	Generator.	CX-1210/U.	Transmit and receive.
	Battery box.	CX-1210/U.	Receive.

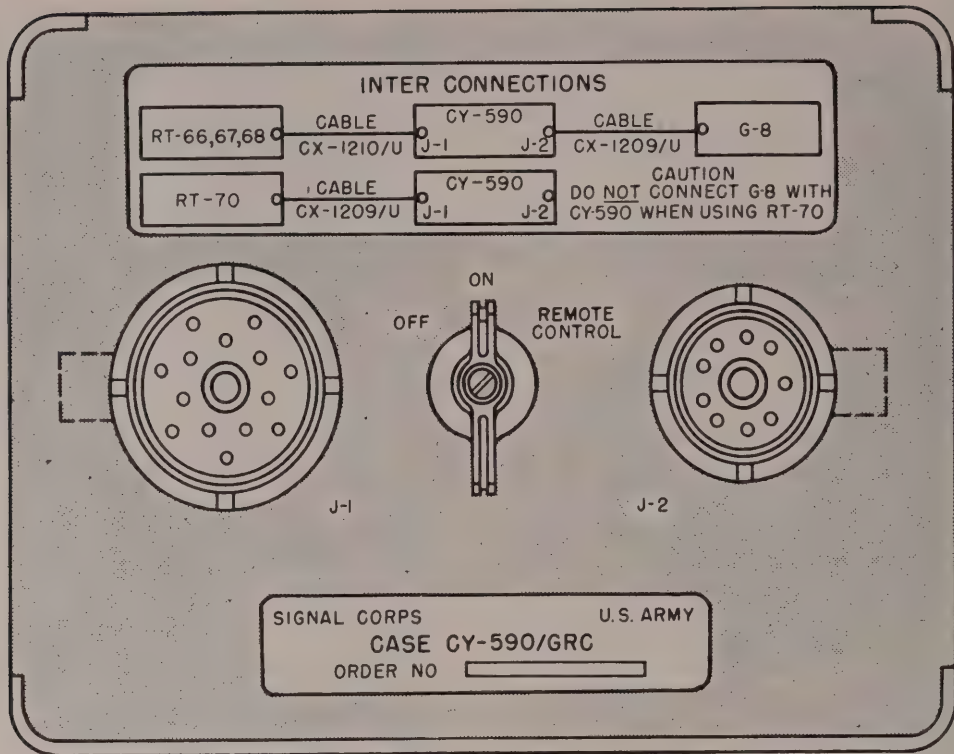
\* When Set 1 is used with the generator and battery box, the generator should not be cranked during receiving.

b. If Control Group AN/GRA-6 is available, remote push-to-talk operation of Set 1 with local control of power is possible.

## 141. Unpacking

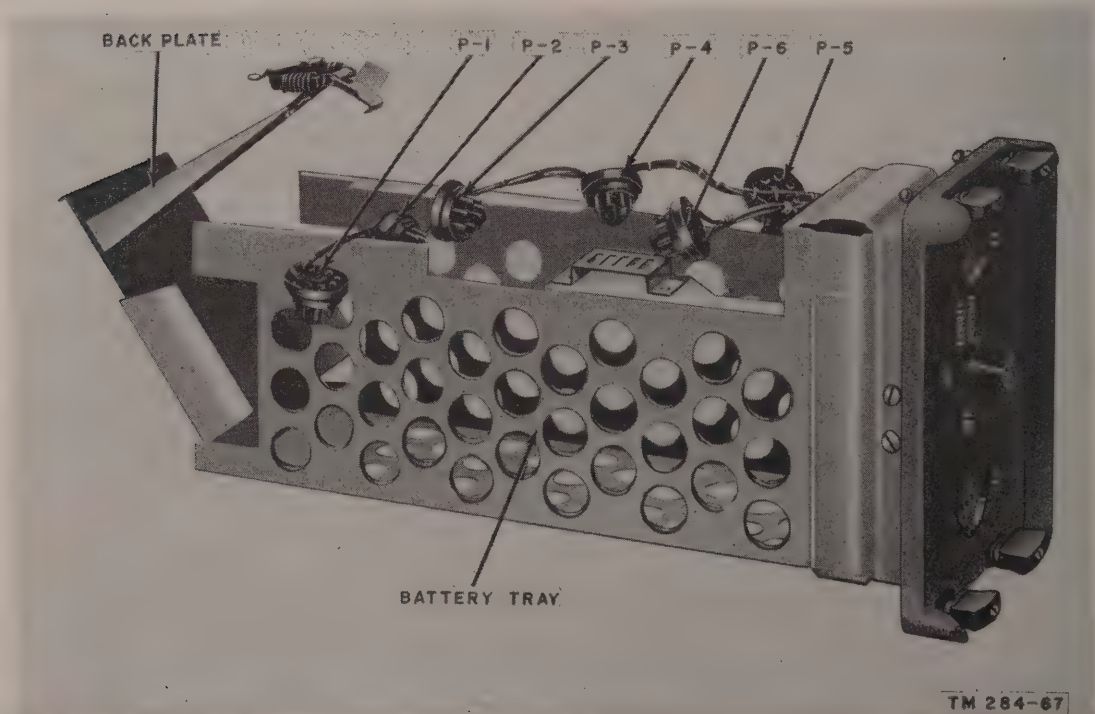
The components of Modification Kit MX-898/GR are packed individually in cardboard containers and are shipped together in a single wooden case. Unpack as follows:

a. Remove the components from the case and remove the wrappings. Store the gener-



TM 286-20

Figure 67. Case CY-590/GRC, front panel.



TM 284-67

Figure 68. Case CY-590/GRC, case and batteries removed.



ator and cables in their original containers or wrappings.

b. Loosen the Dzus fasteners on the panel of the battery case. Remove the battery tray from the case (fig. 68).

c. Install five 1.5-volt Batteries BA-403/U and one 90-volt Battery BA-419/U in the case. Connect the batteries as indicated in figure 69. Replace the battery tray.

d. Store the handset, antenna mounting, mast sections, and Power Cable Assembly CX-1209/U in Bag CW-189/GR. Store the bag in any convenient location in the vehicle.

e. Store the battery case and one Bag CW-188/GR in the other Bag CW-188/GR. Store the packed bag in some convenient location in the vehicle.

## 142. Controls

The only operational controls for the field set-

up (exclusive of controls on the receiver-transmitter and Control Group AN/GRA-6) are the OFF-ON-REMOTE CONTROL switch of the battery box (fig. 67), the hand crank of the generator, and the push-to-talk switch of the handset.

a. *Off-On-Remote Control Switch.* In the OFF position, the 7.5- and 90-volt battery circuits are not connected to ground. In the ON position, the circuits are completed to ground, and battery power is supplied to the receiver-transmitter. The REMOTE CONTROL position is not used in this installation.

b. *Crank GC-7.* Two hand cranks are supplied with the generator. They are inserted into the shaft of the geartrain and turned at a rate of 50 to 70 rpm whenever the operator desires to generate power.

c. *Push-To-Talk Button in Handset H-33/PT.* When the handset is plugged into one of the receptacles on the receiver-transmitter,

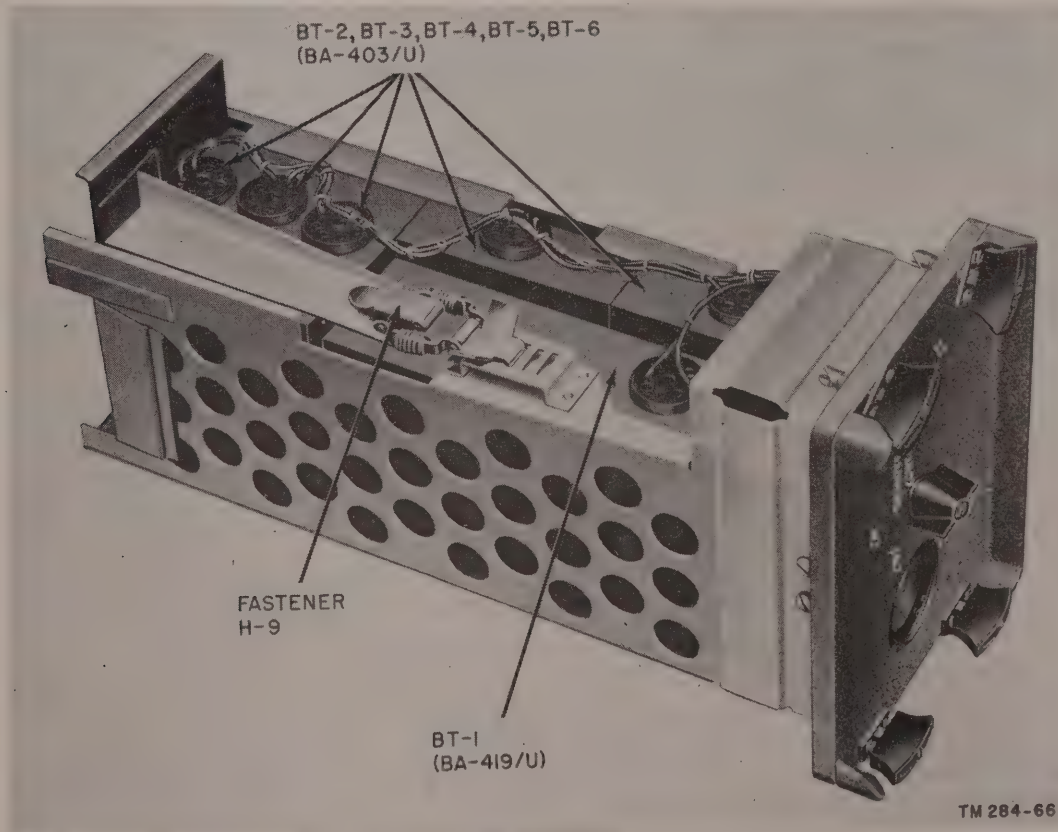


Figure 69. Case CY-590/GRC, case removed and batteries installed.



pressing the push-to-talk button puts Set 1 in the transmit condition. It does this by completing the ground returns for the transmit-control relays and the microphone lines.

#### **143. Installation of Receiver-transmitter with Generator G-8/GRC and Case CY-590/GRC**

(fig. 70)

When Set 1 is used with both the generator and battery box, push-to-talk operation is possible. If Control Group AN/GRA-6 is available, remote push-to-talk operation of the receiver-transmitter is also possible. However, since an operator must remain with the equipment to crank the generator, no provisions are made for remote control of power. To install Set 1 for field operation using Generator G-8/GRC and Case CY-590/GRC, proceed as follows:

a. Remove Set 1 from Mounting MT-297/-GR and pack it in the unused Bag CW-188/-GR. Carry the three bags (two Bags CW-188/-GR and one Bag CW-187/-GR) to the location selected for field operation.

b. Set up the generator, battery case, and Set 1 as illustrated in figure 70. Refer to the manual supplied with the generator for detailed information (TM 11-5037). Turn the OFF-ON-REMOTE CONTROL switch of the battery case to the OFF position.

c. Connect one end of Power Cable Assembly CX-1209/U to the generator and the other end to the nine-pin connector on the battery case.

d. Connect one end of Power Cable Assembly CX-1210/U to the 14-pin connector on the battery case and the other end to the POWER IN receptacle on Set 1.

e. Insert the antenna mounting in the hole at the top front of the receiver-transmitter. Turn the mounting clockwise to lock it in place. Connect the lead-in wire to the ANT connector. For Receiver-Transmitter RT-66/-GRC and RT-67/-GRC, assemble the five mast sections and screw the assembly into the antenna mount. For Receiver-Transmitter RT-68/-GRC, assemble three of the mast sections and screw the assembly into the antenna mount.

f. Connect the handset to one of the AUDIO receptacles on the front of the receiver-transmitter.

g. Set the OFF-ON-REMOTE CONTROL of the battery case to ON. The receiver section of Set 1 is then ready for operation.

h. If Control Group AN/GRA-6 is used, connect the Set 1 cable, which is located behind Local Control C-434/GRC, to one of the AUDIO receptacles on Set 1.

i. Disconnect the handset from the AUDIO receptacles of Set 1 (f above) and connect it to the AUDIO receptacle of the local control unit.

j. Connect Remote Control C-433/GRC to the local control unit by means of a telephone pair as described in paragraph 123. Connect a handset to the AUDIO receptacle of the remote control unit.

#### **144. Operation at Panel with Generator G-8/GRC and Case CY-590/GRC**

a. When the installation has been completed, the signals received by Set 1 may be heard by the operator. It is not necessary to crank the generator while receiving.

b. To transmit, crank the generator at a speed of 50 to 70 rpm (approximately one revolution per second), press the push-to-talk switch, and speak into the mouthpiece. Release the push-to-talk switch (button) and stop cranking to listen.

#### **145. Operation from Control Group AN/GRA-6 with Generator G-8/GRC and Case CY-590/GRC**

a. When the control group is used, it is possible to transmit from either the local or remote unit if the proper switching is performed.

b. To transmit from the local unit, hold the LOCAL switch in the SET 1 position, direct an aide to begin cranking the generator, press the push-to-talk switch, and speak into the mouthpiece.

c. To listen, release the push-to-talk and LOCAL switches and direct the aide to stop cranking the generator.

d. To transmit from the remote unit, direct the local operator (by telephone) to set the REMOTE switch in the SET 1 position and to begin cranking the generator. Set the SELECTOR switch of the remote unit in the left-

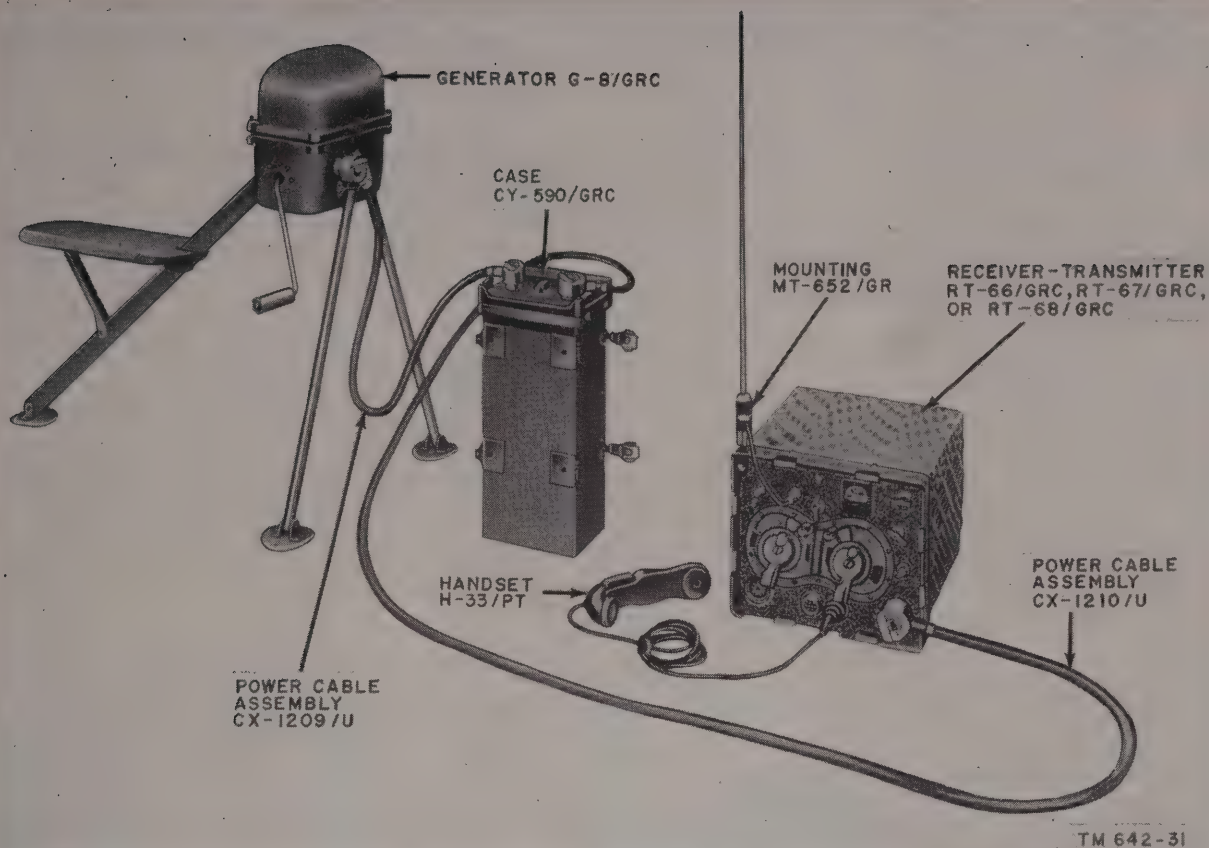


Figure 70. Field operation of receiver-transmitter with Generator G-8/GRC and Case CY-590/GRC.

hand write-in position, press the push-to-talk switch on the handset, and speak into the mouthpiece.

e. To listen, release the push-to-talk switch and signal the local operator (by means of the ringing generator) to stop cranking the generator.

f. To turn off power to the set, turn the OFF-ON-REMOTE CONTROL switch on the battery box to the OFF position.

#### 146. Installation of Receiver-transmitter with Generator G-8/GRC (figs. 71 and 72)

When Set 1 is supplied with power from Generator G-8/GRC alone, the operational facilities available are the same as those given in paragraph 145. However, this installation requires constant cranking when the set is in operation, since the generator must supply both the receiver and transmitter voltages. To in-

stall Set 1 for field operation using Generator G-8/GRC, proceed as follows:

a. Remove Set 1 from Mounting MT-297/GR and pack it in Bag CW-188/GR. If the battery case is not going to be used, remove it from the other Bag CW-188/GR to lighten the burden, and leave it in the vehicle. Take the three bags to the location selected for field operation of the set.

b. Set up the generator and Set 1 as indicated in figure 71. Connect one end of Power Cable Assembly CX-1210/U to the generator and the other end to the POWER IN connector on Set 1. (When Set 1 is used with Generator G-8/GRC alone, the generator supplies all the operating voltages for both the receiver and the transmitter. The block diagram (fig. 72) illustrates the function of the generator.)

c. Connect the antenna mount and mast sections as directed in paragraph 143. Connect the handset to an AUDIO connector on the Set 1 panel.



d. If Control Group AN/GRA-6 is available, connect it to the installation as described in paragraph 143*h* through *j*.

#### 147. Operation of Receiver-transmitter with Generator G-8/GRC

a. When the installation has been completed as directed above, and the generator is cranked, the signals received by Set 1 may be heard by the operator.

b. To transmit from the panel, crank the generator, press the push-to-talk button, and talk into the microphone.

c. To turn off the equipment, stop cranking the generator.

d. Operation with Control Group AN/GRA-6 is the same as given in paragraph 145.

#### 148. Schematic Diagram of Connections Between Generator G-8/GRC and the Receiver-transmitter (fig. 73)

The generator supplies the same voltages to receptacle J-309 of the receiver-transmitter in a field installation as the power supply (PP-109/GR or PP-112/GR) in a vehicular installation. Terminals H and J of receptacle J-309 in the receiver-transmitter are shorted by a jumper in Power Cable Assembly CX-1210/U. This duplicates the connection made in Mounting MT-297/GR in vehicular installations. Power Cable Assembly CX-1210/U is wired symmetrically so that either end may be plugged into the generator or the receiver-transmitter.

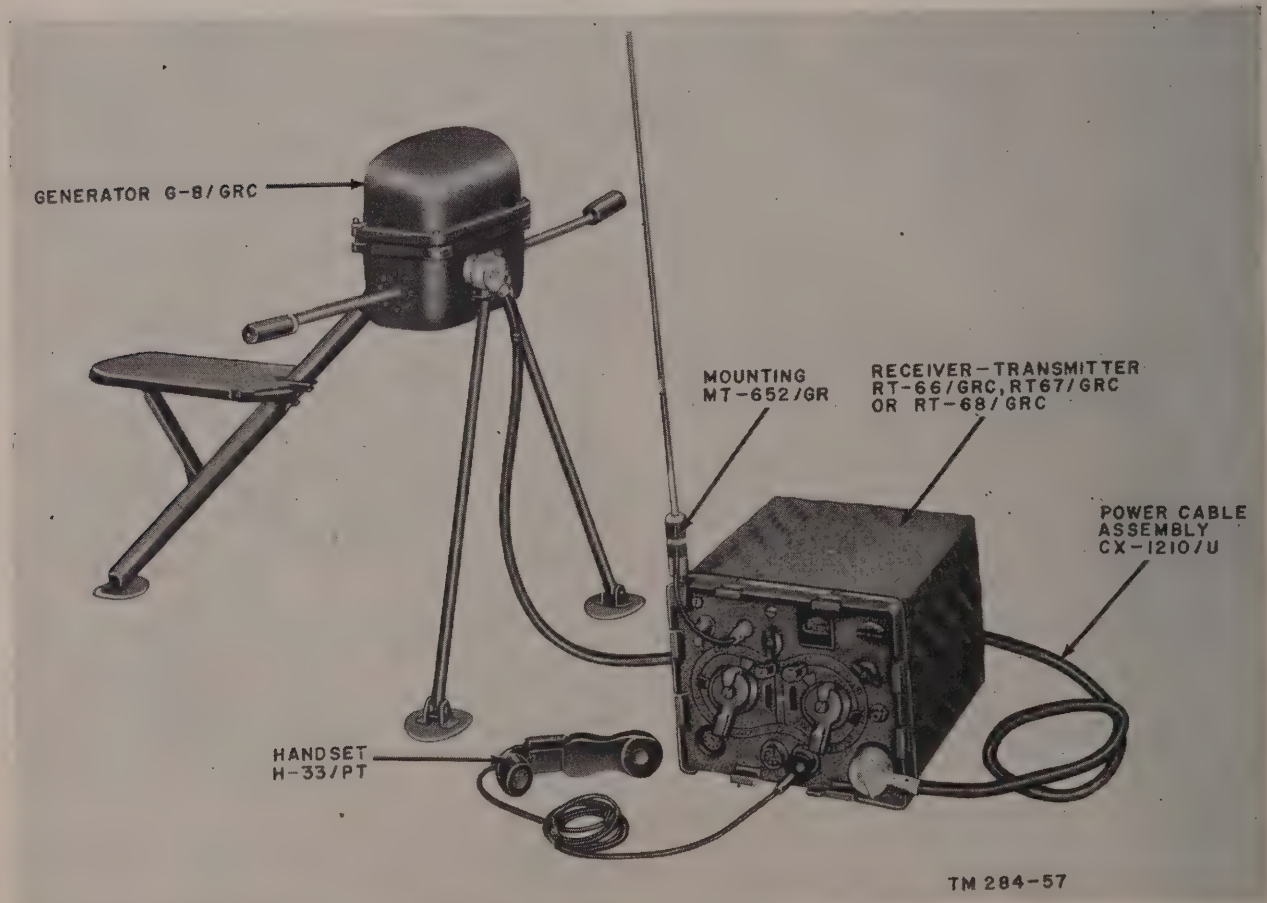
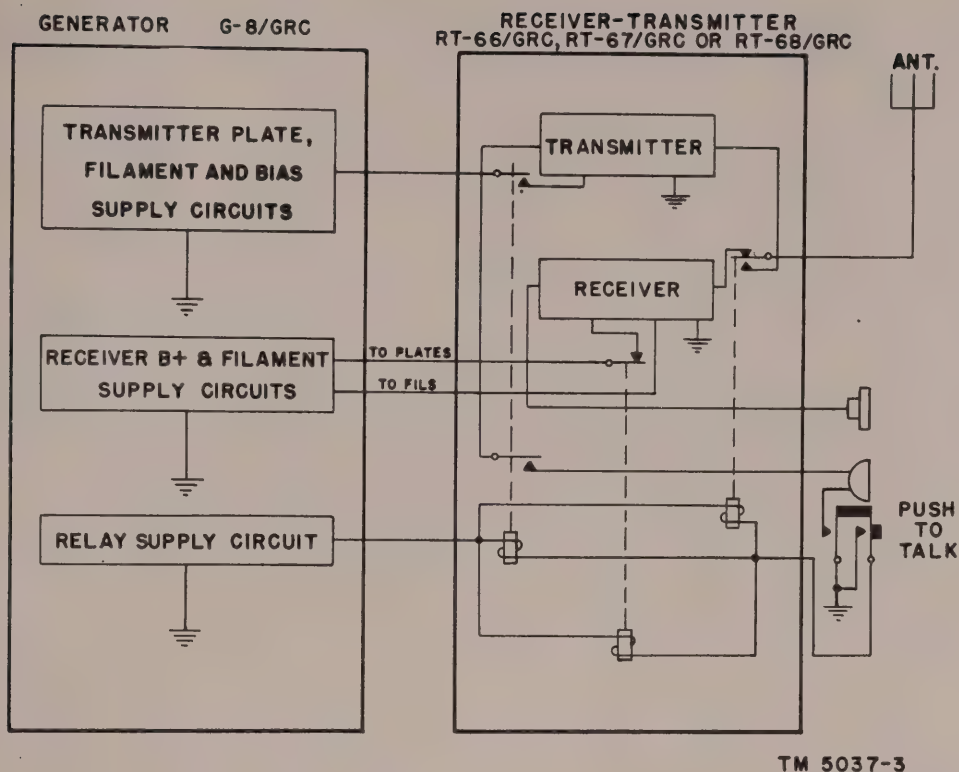


Figure 71. Field operation of receiver-transmitter with Generator G-8/GRC.





TM 5037-3

Figure 72. Block diagram of Generator G-8/GRC and receiver-transmitter.

#### 149. Schematic Diagram of Connections Between Generator G-8/GRC, Case CY-590/GRC, and Receiver-transmitter (fig. 74)

Case CY-590/GRC serves two functions: First, it powers the receiver section of the receiver-transmitter, the filament circuits at terminal L of J-309, and the plate circuits at terminal B of J-309. Second, it connects only those voltages from Generator G-8/GRC to the receiver-transmitter that powers the transmitter section.

a. Resistor R-2 is a voltage-dropping resistor in series with the 7.5-volt battery (BA-403/U) in Case CY-590/GRC, which drops the voltage to 6.3 at the receiver filaments. (Resistors R-1 and R-3 do not function in this installation.) Switch S-1 (OFF-ON-REMOTE CONTROL) is a three-position switch. In the OFF position of this switch, the ground returns of the 90-volt battery (BA-419/U) and the 7.5-volt battery are open. In the ON position, these ground returns are completed. In the REMOTE CONTROL position (not used in this installation) these returns are set up for

completion by switches and relays in Control Group AN/GRA-6.

b. The output voltages of Generator G-8/GRC are applied to the receiver-transmitter through Cable CX-1209/U, wiring connections between receptacles J-2 and J-1 of Case CY-590/GRC, and Power Cable Assembly CX-1210/U. The wiring in Power Cable Assembly CX-1209/U and between receptacles J-2 and J-1 has two functions: It establishes circuits from the generator to the transmitter section of the receiver-transmitter, and leaves open the circuits from the generator to the receiver section of the receiver-transmitter. The circuits left open are the receiver filament supply (terminal L of J-1 on the generator) and the receiver plate supply (terminal B of J-1 on the generator). These generator outputs are replaced by voltages supplied by the batteries in Case CY-590/GRC. The combination of voltages supplied by the batteries and those which are wired through from the generator appear at receptacle J-1 of Case CY-590/GRC. From here they are applied through Power Cable Assembly CX-1210/U to the receiver-transmitter.

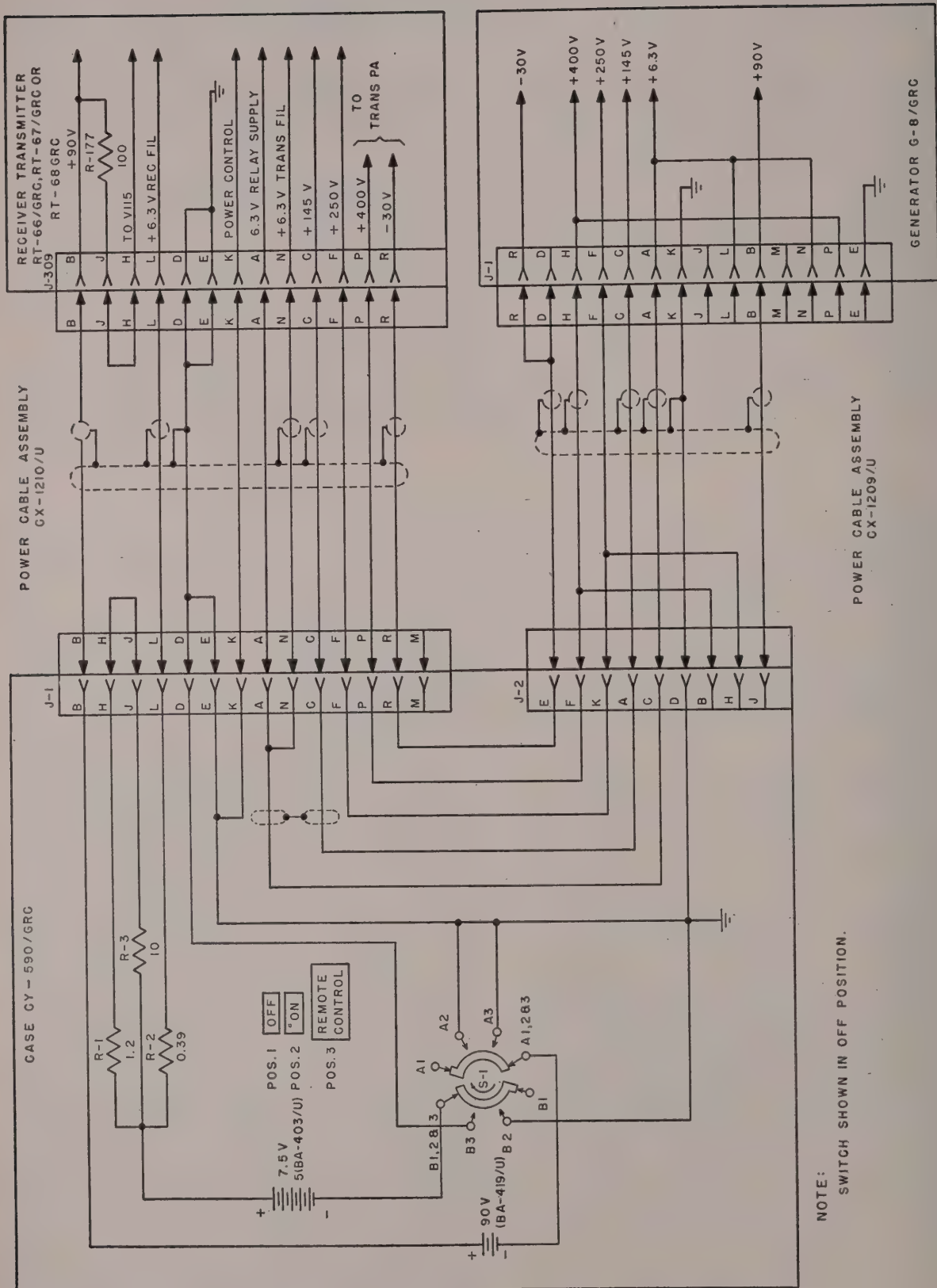
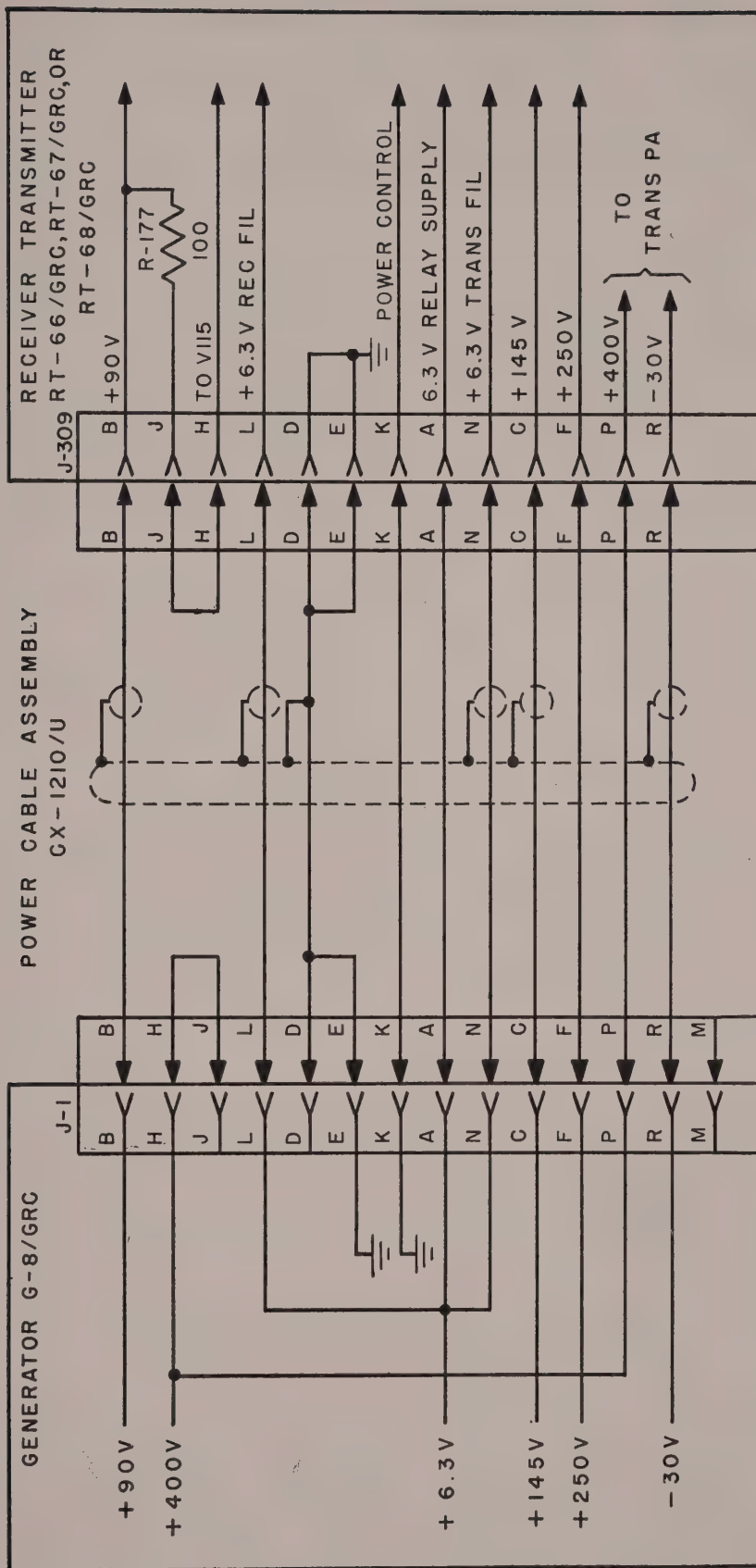


Figure 73. Schematic diagram of connections between Generator G-8/GRC and receiver-transmitter.



TM 642-22

Figure 74. Schematic diagram of connections between Generator G-8/GRC, Case CY-590/GRC, and receiver-transmitter.



## Section IV. MISCELLANEOUS AUXILIARY FACILITIES

### 150. Elevated Antenna Equipment RC-292

Elevated Antenna Equipment RC-292 can be used with Radio Set AN/VRC-20, -21, or -22 to extend the communication range to 25 miles (TM 11-5020).

### 151. Receiver-Transmitter RT-70/GRC

Receiver-Transmitter RT-70/GRC can be interconnected with Radio Set AN/VRC-20, -21, or -22 to provide additional receiving and transmitting facilities. When properly interconnected, the resulting combinations have the same facilities as Radio Set AN/GRC-3, -5, or -7, respectively, except for retransmission. The

addition of Control C-435/GRC provides for retransmission.

### 152. Duplex Operation of Radio Sets AN/VRC-20, -21, and -22

Radio Sets AN/VRC-20, -21, and -22 can be set up for full duplex operation, as follows:

*a.* Disconnect Wire W-142 between the ANT connectors of the auxiliary receiver and the receiver-transmitter.

*b.* Connect an antenna equivalent to the one being used on the receiver-transmitter to the ANT connector on the auxiliary receiver.

*c.* Select frequencies of operation that cause no interference between units (par. 37b).

## CHAPTER 7

### SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

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#### Section I. SHIPMENT AND LIMITED STORAGE

##### 153. Disassembly

The following instructions are recommended as a guide for preparing the radio set for transportation and storage. Reverse the procedure followed in assembling the equipment according to the paragraph references given below.

###### *a. Disconnection of Cables.*

- (1) Disconnect all audio accessories from their receptacles on the units and coil the cords neatly.
- (2) Remove all the interconnecting cables between the units (fig. 27).
- (3) Disconnect the battery cable (cable W-8 of Mounting MT-297/GR) from the battery or the vehicular junction box, depending on the particular installation (fig. 27).
- (4) Remove the antenna cable adapters from their installations on the mast bases and on the receiver-transmitters.
- (5) Disconnect the antenna cables from the adapters and coil them neatly.

###### *b. Removal of Units.*

- (1) Remove AF Amplifier AM-65/GRC from the mounting.
- (2) Remove the Set 1 power supply from the mounting.
- (3) Remove the receiver-transmitter from the mounting.

- (4) Remove the auxiliary receiver from the mounting.
- (5) Remove Control Box C-375/VRC from its mounting surface on the vehicle.
- (6) Remove Mounting MT-297/GRC from its vehicular installation.

###### *c. Removal of Antenna.*

- (1) Remove the antenna mast sections from the mast base.
- (2) Remove the antenna mast base from its mounting surface.

##### 154. Repacking for Shipment or Limited Storage

*a.* The exact procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Refer to paragraph 8 for a description of the original packing.

*b.* Whenever practicable, place a dehydrating agent such as silica gel inside the chests. Protect the chests with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected chests in a padded wooden case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

#### Section II. DEMOLITION OF MATÉRIEL TO PREVENT ENEMY USE

##### 155. General

The demolition procedures outlined in paragraph 156 will be used to prevent the salvaging of this equipment by the enemy. Demolition of the equipment will be undertaken only upon order of the commander.

##### 156. Methods of Destruction

*a. Smash.* Smash the crystals, controls, tubes, coils, switches, capacitors, transformers, microphones, and headsets, using sledges, axes, handaxes, pickaxes, hammers, crowbars, or any other heavy tools available.

*b. Cut.* Cut cords, cables, headsets, and wiring, using axes, handaxes, machetes, or bayonets.

*c. Burn.* Burn cords, cables, resistors, capacitors, coils, wiring, and technical manuals, using gasoline, kerosine, oil, flame throwers, or incendiary grenades.

*d. Bend.* Bend panels, cases, chassis, mounting, and antenna mast sections.

*e. Explosives.* If explosives are necessary use firearms, grenades, or TNT.

*f. Disposal.* Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

*g. Destroy Everything.*



# APPENDIX I

## REFERENCES

*Note.* For availability of items listed, check SR 310-20-3, SR 310-20-4, and SR 310-20-5. Check Department of the Army Supply Catalog SIG 1 for Signal Corps supply catalog pamphlets.

### 1. Army Regulations

- AR 380-5 Military Security (Safeguarding Military Information).
- AR 750-5 Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation).

### 2. Supply Bulletins

- SB 11-6 Dry Battery Supply Data.
- SB 11-47 Preparation and Submission of Requisitions for Signal Corps Supplies.
- SB 11-76 Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

### 3. Components of Radio Sets AN/VRC-20, -21, -22

- TM 11-289 Receiver-Transmitter RT-66/GRC, RT-67/GRC, and RT-68/GRC.
- TM 11-898 Radio Receivers R-108/-GRC, R-109/GRC, and R-110/GRC.
- TM 11-5036 Power Supplies PP-109/-GR and PP-112/GR.
- TM 11-5039 AF Amplifier AM-65/-GRC.
- TM 11-5040 Power Supplies PP-281/-GRC, PP-282/GRC, and PP-448/GR.

### 4. Auxiliary Equipment and Test Equipment

- TM 11-300 Frequency Meter Sets SCR-211-A, B, C, D, E, F, J, K, L, M, N, O, P, Q, R, T, AA, AC, AE,

- AF, AG, AH, AJ, AK, AL.
- TM 11-303 Test Sets I-56-C, I-56-D, I-56-H, and I-56-J.
- TM 11-307 Signal Generators I-72-G, H, J, K, and L.
- TM 11-321 Test Set I-56-E.
- TM 11-4700 Electrical Indicating and Measuring Instruments, Repair Instructions.
- TM 11-2524 Oscillators I-151-A and I-151-E.
- TM 11-2613 Voltohmmeter I-166.
- TM 11-2624B Voltohmmeters TS-294/U, TS-294B/U, and TS-294C/U.
- TM 11-2626 Test Unit I-176, I-176-A, and I-176-B.
- TM 11-2627 Tube Tester I-177 and I-177-A.
- TM 11-5020 Antenna Equipment RC-292.
- TM 11-5030 Signal Generator TS-497-A/URR.
- TM 11-5037 Generator G-8/GRC.
- TM 11-5038 Control Group AN/GRA-6.
- TM 11-5511 Electronic Multimeter TS-505/U.
- TM 11-5527 Multimeter TS-352/U.

### 5. Painting, Preserving, and Lubrication

- TB SIG 13 Moistureproofing and Fungiproofing Signal Corps Equipment.
- TB SIG 69 Lubrication of Ground Signal Equipment.
- TB SIG 212 Low Temperature Lubricants for Meteorological Equipment.
- TM 9-2851 Painting Instructions for Field Use.

## 6. Camouflage, Decontamination, and Demolition

FM 5-20	Camouflage, Basic Principles.
FM 5-25	Explosives and Demolitions.
TM 3-220	Decontamination.

## 7. Other Publications

FM 24-18	Field Radio Techniques.
FM 72-20	Jungle Warfare.
SR 700-45-5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD-247).
SR 745-45-5	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD-66 (Army) and AF-MC-U2 (Air Force)).
AFR 71-4	
TB SIG 4	Methods for Improving the Effectiveness of Jungle Radio Communication.
TB SIG 25	Preventive Maintenance of Power Cords.
TB SIG 54	Working Through Jamming with Frequency Modulated Radio Sets. <i>Note.</i> Use on FM sets only.)
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TB SIG 223	Field Expedients for Wire and Radio.

TB 11-499-( ) \*Basic Radio Propagation Predictions.

TM 9-2857	Storage Batteries Lead-Acid Type.
TM 11-310	Schematic Diagrams for Maintenance of Ground Radio Communication Sets.
TM 11-314	Antennas and Antenna Systems.
TM 11-415	Dry Batteries.
TM 11-430	Batteries for Signal Communication. Except those pertaining to Aircraft.
TM 11-453	Shop Work.
TM 11-455	Radio Fundamentals.
TM 11-466	Radar Electronic Fundamentals.
TM 11-476	Radio Direction Finding.
TM 11-483	Suppression of Radio Noises.
TM 11-486	Electrical Communication Systems Engineering.
TM 11-496	Training Text and Applicatory Exercises for Amplitude-Modulated Radio Sets.
TM 11-499	(Preliminary), Radio Propagation Handbook.
TM 11-660	Introduction to Electronics.
TM 11-661	Electrical Fundamentals (Direct Current).
TM 11-681	Electrical Fundamentals (Alternating Current).
TM 11-4000	Trouble Shooting and Repair of Radio Equipment.

## 8. Abbreviations

a-c	alternating-current
a-f	audio-frequency
a-m	amplitude-modulation
afc	automatic frequency control
C	centigrade
db	decibel(s)
dc	direct current
DPST	double-pole, single-throw
F	Fahrenheit
f-m	frequency-modulation
hf	high frequency
hv	high voltage

\* A new TB in this series is issued monthly which gives propagation predictions 3 months in advance.

i-f.....intermediate-frequency  
lv.....low voltage  
kc.....kilocycle  
ma.....milliampere  
mc.....megacycle  
mw.....milliwatt  
rf.....radio frequency  
rpm.....revolutions per minute

ua.....microampere  
uf, uuf.....microfarad, micromicrofarad  
uv.....microvolt

## 9. Glossary

For explanation of terms used in this manual,  
see TM 11-455.



## APPENDIX II IDENTIFICATION TABLE OF PARTS

*Note.* The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite a specific T/O&E, T/A, SIG 7&8, list of allowances of expendable material, or another supply basis. The Department of the Army Supply Catalogs applicable to the equipment covered in this manual are SIG 7&8 MT-297/GR and SIG 7&8 C-375/VRC. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1.

### I. Scope of Identification Table of Parts

This technical manual contains the identification tables of parts for Mounting MT-297/GR and Control Box C-375/VRC. Identification tables of parts for the individual components are listed in the technical manuals which describe these components.

### 2. Identification Table of Parts for Mounting MT-297/GR

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	MOUNTING MT-297/GR: metal rack w/8 metal rack surface plates and 9 metal channels ea w/locking strips; olive drab finish; main power ckt term. 80 amp cap; 33 $\frac{5}{8}$ " lg x 13 $\frac{3}{8}$ " d x 4 $\frac{13}{16}$ " h; moistureproof and fungi-proof.		2Z6763-297
	TECHNICAL MANUAL TM 11-284.		Order through AGO.
	TECHNICAL MANUAL TM 11-642.		Order through AGO.
E-2, E-5	BOARD, terminal: general purpose; 18 solder type term.; 5 $\frac{3}{8}$ " lg x 2 $\frac{5}{16}$ " wd x 1 $\frac{1}{8}$ " h o/a; term. marked from A to K and from A-1 to K-1, omitting G and I, mtg bkt on ea end.	Cable terminating boards.	3Z770-18.46
E-6	BOARD, terminal: general purpose; 18 solder type term. 5 $\frac{3}{8}$ " lg x 2 $\frac{5}{16}$ " wd x 1 $\frac{1}{8}$ " h o/a; term. marked from 1 to 18, mtg bkt on ea end.	Cable terminating board.	3Z770-18.45
H-11	BUTTON, plug: fits 1 $\frac{9}{32}$ " dia hole; .587" dia x 1 $\frac{3}{8}$ " lg o/a.	Cable clamp plug.	4Z3152
W-4	CABLE ASSEMBLY, power: uses Cordage CO-212; 1' 6 $\frac{1}{2}$ " lg excluding terminations.	Power cable.	3E7350.1-18.3
W-1	CABLE ASSEMBLY, power: uses Cordage CO-212; 1' 7 $\frac{1}{2}$ " lg excluding terminations.	Power cable.	3E7350.1-19.3
W-5	CABLE ASSEMBLY, power: uses Cordage CO-212; 1' 8" lg excluding terminations.	Power cable.	3E7350.1-20.4
W-8	CABLE ASSEMBLY, power: uses Cordage CO-212; 8' 6" lg excluding terminations.	Battery cable.	3E7350.1-102.1
W-6	CABLE ASSEMBLY, special purpose: uses Special Purpose Cable WM-46/U; 1' 9" lg excluding terminations.	Control cable.	3E7350-1.21.1
W-7	CABLE ASSEMBLY, special purpose: uses Special Purpose Cable WM-46/U; 1' 11" lg excluding terminations.	Control cable.	3E7350-1.23.1
W-2	CABLE ASSEMBLY, special purpose: uses Special Purpose Cable WM-46/U; 1' 11" lg excluding terminations.	Control cable.	3E7350-1.23.2
W-3	CABLE ASSEMBLY, special purpose: uses Special Purpose Cable WM-46/U; 2 $\frac{1}{2}$ ' lg excluding terminations.	Control cable.	3E7350-1.24
O-13	CAM: connector locking cam.	Connector locking cam.	4Z3185-2

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
O-4 through O-12	CAM: mtg plate locking cam.	Locking cams.	4Z3185-1
H-7 through H-10	CLAMP: cable; accom .516" dia cable.	Cable clamps.	2Z2642.300
H-1 through H-6	CLAMP: cable; accom .61" dia cable.	Cable clamps.	2Z2642.305
O-15 through O-18	COLLAR, spacing: rack mtg spacer.	Rack to bracket mounting spacers.	2Z8552-71
J-1	CONNECTOR, receptacle: 26 round female cont; straight.	Receptacle control unit connector.	2Z3082-84
F-2	FUSE, cartridge: 2 amp.	Circuit fuse.	3Z2602.23
F-1	FUSE, cartridge: 50 amp.	Overload protection, battery.	3Z2650.11
E-10	FUSEHOLDER: block type; for single type 5AG cartridge fuse; 30 amp, 32 v dc max.	Fuseholder.	3Z3282-20.6
E-9	FUSEHOLDER: block type; for single type 5AG cartridge fuse; 80 amp, 32 v dc max.	Fuseholder.	3Z3282-1.1
O-29, O-30	GASKET: cover to junction box wp gasket; JW60 crude rubber compound; single hole; cir w/round cross sect., 6 $\frac{3}{4}$ " OD x 6 $\frac{1}{2}$ " ID x $\frac{1}{8}$ " thk.	Cover to junction box waterproof gasket.	2Z4868.786
O-28	GASKET: cover to junction box wp gasket; JW60 crude rubber compound; single hole; cir w/round cross sect., 10 $\frac{1}{4}$ " OD x 10" ID x $\frac{1}{8}$ " thk.	Cover to junction box waterproof gasket.	2Z4868.785
H-12 through H-20	HANDLE: mtg strip locking handle; 2 $\frac{5}{16}$ " lg x 1 $\frac{1}{2}$ " wd x $\frac{7}{16}$ " h o/a.	Mounting strip locking handle.	4Z4691
E-13, E-14	INSULATOR, plate: rectangular shape; type #LTS-E-3 natural phenolic per spec JAN-P-13; 1 $\frac{1}{2}$ " lg x 1 $\frac{1}{4}$ " wd x .062" thk, two .169" dia mtg holes on 1" mtg/c.	Terminal assembly mounting insulator.	3G320-165
E-16	INSULATOR, plate: rectangular shape; type #LTS-E-3 natural phenolic per spec JAN-P-13; 1 $\frac{5}{8}$ " lg x $\frac{5}{8}$ " wd x .062" thk, two .169" dia mtg holes on .313" x .25" mtg/c.	Fuseholder mounting insulator.	3G320-167
E-15	INSULATOR, plate: rectangular shape; type #LST-E-3 natural phenolic per spec JAN-P-13; 1 $\frac{13}{16}$ " lg x 1 $\frac{11}{16}$ " wd x .062" thk, two .169" dia mtg holes on 1" mtg/c.	Fuseholder mounting insulator.	3G320-166
E-17	JUNCTION BOX: cable terminating and connector, term. board, fuseholder, and sw mtg box; ten .828" dia outlet holes.	Cable terminating junction box.	2Z5687-35
E-18	KNOB: bar; zinc alloy, olive drab finish; for $\frac{1}{4}$ " dia double flatted shaft; 2 white luminous lines.	Switch knob.	2Z5822-401
N-1	LABEL: ckt label; 1 $\frac{3}{16}$ " wd x 9 $\frac{7}{8}$ " lg x .007" thk.	Circuit label for Mounting MT-297/GR.	6D16777-9
E-7	LAMP LM-38: 28 v, .17 amp; miniature bayonet base.	Pilot light.	2Z5938
W-9, W-10	LEAD, electrical: flat ribbon shape approx $\frac{5}{8}$ " wd x $\frac{1}{8}$ " thk; 5 $\frac{1}{2}$ " lg excluding terminations.	Grounding straps.	3E7998-5.9
I-1	LIGHT, indicator: w/lens; for miniature bayonet base.	Pilot light socket.	2Z5991-184

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
O-2, O-3 H-21 H-101 through H-108 E-4, E-12 E-1, E-3 O-1	MOUNTING: for mtg plug connector not in use. NUT, castellated: $\frac{3}{8}$ "-32 NS-2. NUT, hexagon: $\frac{5}{16}$ "-24 NF-2.  POST, binding: compression screw type; $1\frac{1}{2}$ " lg x $\frac{1}{2}$ " wd x $1\frac{1}{32}$ " h. POST, binding: compression screw type; $1\frac{1}{2}$ " lg x $1\frac{1}{16}$ " wd x $1\frac{1}{2}$ " h. RELAY, armature: cont arrangement 3B; 12.6 v dc nom pull in voltage 8 v dc, max oper voltage or 16 v dc.	Mounts connector not being used. Switch mounting nut.  Ground terminals. Cable terminals. Control relay.	2Z1409-191 6L3006-32S 6L3505-24-8.3S  3Z741-2 3Z741-2.1 2Z7599A-251
K-1	RELAY, solenoid: SPST, normally open; operates on 10 v dc, continuously withstands 16 v dc.	Power relay.	2Z7586-193
R-3	RESISTOR, fixed: WW; 28 ohms $\pm 5\%$ ; 12 w; JAN type RW32F280.	Voltage-dropping resistor.	3RW15006
R-1, R-2	RESISTOR, fixed: WW; 140 ohms $\pm 5\%$ ; 8 w; JAN type RW29F141.	Voltage-dropping resistors.	3RW19207
H-24 through H-27 H-38 through H-47 H-28 through H-37 H-48 through H-67 H-77 through H-85 H-68 through H-76 H-86 through H-89 O-14	SCREW, cap: slotted hex. head drive; hex. head; $\frac{1}{4}$ "-20 NC-2; $\frac{3}{8}$ " lg.  SCREW, cap: slotted drive; hex. head, $\frac{5}{16}$ "-24 NF-2; $\frac{3}{4}$ " lg.  SCREW, cap: slotted drive; hex. head; $\frac{5}{16}$ "-24 NF-2; $1\frac{1}{4}$ " lg.  SCREW, captive: slotted drive; fillister Bind H; #10-24 NC-2; .937" lg.  SCREW, dowel: handle and cam assy screw.  SCREW, dowel: handle, cam and locking strip assy screws.  SCREW, thumb: wing head; $\frac{5}{16}$ "-18 NC-2; $1\frac{1}{4}$ " lg.  SHAFT ASSEMBLY: connector locking cam oper shaft.	Rack to bracket mounting screws.  Equipment installation screws.  Equipment installation screws.  Junction box cover mounting screws.  Handle and cam assembly screws.  Handle, cam, and locking strip assembly screws.  Stand assembly (hinged) locking screws.  Connector locking cam operating shaft.	6L4904-20-6 6L4905-12S 6L4905-20S 6L4770-15.21SF 6L5014-6-1 6L5014-10 6L17504-4 2Z8201.69
A-1 through A-8 O-19 through O-27 S-1	SHOCKMOUNT M-449: sq mtg; $2\frac{3}{8}$ " sq o/a.  SPRING: helical extension type; locking strip tension spring; 1.86" lg x .375" dia o/a; 27 $\frac{1}{2}$ turns close wnd. SWITCH, rotary: 2 pole 3 position; single sect.	Shock mounts.  Locking strip tension springs. Control switch.	2Z8415-449 2Z8879-323 3Z9825-62.516
E-8, E-11 H-90, H-91	TERMINAL, lug: ring type; for #8 AWG wire. WASHER, flat: round, $1\frac{3}{16}$ " OD x $1\frac{3}{32}$ " ID x $\frac{1}{8}$ " thk.	Battery cable terminals.  Unused cable connector mounting shock absorbing washers.	3Z12073-53 6L54006-21
H-109 through H-116	WASHER, lock: cir, .326" nom ID x .890" nom OD x .035" thk.		6L72218-24C



### 3. Identification Table of Parts for Control Box C-375/VRC

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
	CONTROL BOX C-375/VRC: interphone and radio push-to-talk operation.	Remote control for interphone amplifier and radio sets.	2C666-375
	BOARD, terminal: general purpose; 2 solder lug term., copper silver pl; $1\frac{5}{16}$ " lg x $2\frac{9}{32}$ " h x $\frac{5}{16}$ " thk o/a.	Junction point for interunit connections.	3Z770-2.49
H-1, H-2	CLAMP: used to hold cable and wp cable entrance; wp.	Secure interconnecting Special Purpose Cables WM-46/U.	2Z2642.241
J-1, J-2	CONNECTOR, receptacle: Receptacle Connector U-79/U; 10 cont, pol; straight.	Connectors for audio input, output, and control circuits.	2Z7250-79
A-2	COVER	Used to waterproof Jacks JK-33-C and JK-34-C.	2Z3352.224
J-3, J-4	JACK JK-33-C: for 3 cond plug .2065" dia x 1.093" lg.	Connect microphone to audio input circuit.	2Z5533C
J-5, J-6	JACK JK-34-C: for 2 cond plug .250" dia x $1\frac{7}{32}$ " lg.	Connect headset to output of audio circuit.	2Z5534C
	KNOB: bar; aluminum, olive drab finish; for $\frac{1}{4}$ " dia double flattened shaft; luminous ctr line; $1\frac{3}{16}$ " lg x $\frac{7}{8}$ " wd x $1\frac{5}{32}$ " thk.	For shaft of volume controls.	2Z5821-147
	KNOB: bar; aluminum, olive drab finish; for $\frac{1}{4}$ " dia double flattened shaft; luminous ctr line; $1\frac{15}{16}$ " lg x $\frac{7}{8}$ " wd x $1\frac{5}{32}$ " thk.	For shaft to switch S-2 ( R A D I O TRANS).	2Z5821-148
	KNOB: bar; aluminum, olive drab finish; for $\frac{1}{4}$ " dia double flattened shaft; luminous ctr line; $2\frac{15}{16}$ " lg x $\frac{7}{8}$ " wd x $\frac{7}{16}$ " thk.	For shaft of selector switch S-1.	2Z5821-149
R-1, R-2	RESISTOR, variable: comp; 10,000 ohms $\pm 10\%$ ; 2.25 w.	Volume controls for audio output.	3Z7410-149
S-2	SWITCH, rotary: 2 pole, 3 position.	Selects interphone amplifier and radio sets for transmitting.	3Z9825-34.2
S-1	SWITCH, rotary: 3 pole, 3 position.	Selects interphone amplifier and radio sets for monitoring and transmitting.	3Z9825-34.1

# APPENDIX III

## RELATED RADIO SETS

### I. Basis of Relationship

The major components of the radio sets discussed in this manual are common to numerous other sets which use common or overlapping frequency ranges. The frequency spectrum chart (fig. 2) indicates the relationship of the sets insofar as frequency coverage is concerned. Physical similarities among the sets are indi-

cated in the comparison chart included below.

### 2. Comparison Chart

The following chart lists the components of the radio sets discussed in this manual and the components of related radio sets. Analysis of the chart and figure 97 reveals the high degree of similarity which exists among the sets.

Components	Radio Sets																								
	Radio Set AN/GRC-3	Radio Set AN/GRC-5	Radio Set AN/GRC-7	Radio Set AN/GRC-4	Radio Set AN/GRC-6	Radio Set AN/GRC-8	Radio Set AN/VRC-8	Radio Set AN/VRC-9	Radio Set AN/VRC-10	Radio Set AN/VRC-13	Radio Set AN/VRC-14	Radio Set AN/VRC-15	Radio Set AN/VRC-16	Radio Set AN/VRC-17	Radio Set AN/VRC-18	Radio Set AN/VRC-20	Radio Set AN/VRC-21	Radio Set AN/VRC-22	Radio Set AN/VRQ-1	Radio Set AN/VRQ-2	Radio Set AN/VRQ-3	Radio Set AN/VRQ-7	Radio Set AN/PRC-16	Intercommunication Set AN/UIC-1	Modification Kit MX-898/GR
Case CY-684/GR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1			
Case CY-590/GR																							1		1
Mounting MT-297/GR	1	1	1	1	1	1				1	1	1				1	1	1							
Mounting MT-299/GR								1	1	1															
Mounting MT-298/GR																			1	1	1				
Mounting MT-300/GR														1	1	1						1		1	
Mounting MT-327/GR																									
Mounting MT-673/GR																								1	
Antenna Mounting MT-652/GR																							1		1
Receiver-Transmitter RT-66/GRC	1			1			1			1			1			1			2						
Receiver-Transmitter RT-67/GRC		1			1			1			1			1			1			2					
Receiver-Transmitter RT-68/GRC			1			1			1			1			1			1			2				
Receiver-Transmitter RT-70/GRC	1	1	1	1	1	1																1	1		
AF Amplifier AM-65/GRC	1	1	1	1	1	1					1	1	1				1	1	1			1		1	
Power Supply	2	2	2	1	1	1					1	1	1	1	1	1	2	2	2			1		1	
PP-282/GRC or PP-281/GRC																									
Power Supply PP-448/GR																						1			
Radio Receiver R-108/GRC	1													1			1								
Radio Receiver R-109/GRC		1													1			1							
Radio Receiver R-110/GRC			1													1			1						
Power Supply	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2			
PP-109/GR or PP-112/GR																									
Control Group AN/GRA-6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1	1		
Control C-435/GRC	1	1	1	1	1	1														1	1	1			
Control Box C-375/VRC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		2
Mast Base AB-15/GR	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1		
Mast Section MS-116-A	2	2		2	2		2	2		2	2		2	2		2	2	1	1	4	4				
Mast Section MS-117-A	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	4	4	4			
Mast Section MS-118-A	2	2		2	2		2	2		2	2		2	2		1	1		4	4					
Mast Section AB-22/GR	2	2	2	2	2	2																2	2		1

## Radio Sets

## Components

	Radio Set AN/GRC-3	Radio Set AN/GRC-5	Radio Set AN/GRC-7	Radio Set AN/GRC-4	Radio Set AN/GRC-6	Radio Set AN/GRC-8	Radio Set AN/VRC-8	Radio Set AN/VRC-9	Radio Set AN/VRC-10	Radio Set AN/VRC-13	Radio Set AN/VRC-14	Radio Set AN/VRC-15	Radio Set AN/VRC-16	Radio Set AN/VRC-17	Radio Set AN/VRC-18	Radio Set AN/VRC-20	Radio Set AN/VRC-21	Radio Set AN/VRC-22	Radio Set AN/VRQ-1	Radio Set AN/VRQ-2	Radio Set AN/VRQ-3	Radio Set AN/VRQ-7	Radio Set AN/PRC-16	Intercommunication Set AN/UIC-1	Modification Kit MX-898/GR
Mast Section AB-24/GR	2	2	4	2	2	4			2			2			2			1			4	2	2		1
Mast Section AB-23/GR																									3
Generator G-8/GRC																									1
Handset H-33/PT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Special Purpose Cable Assembly CX-1211/U	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2				
Special Purpose Cable Assembly CX-1213/U	1	1	1	1	1	1																1			
Special Purpose Cable WM-46/U	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	
RF Cable Assembly CG-568/U	1			1			1			1			1			1			2						
RF Cable Assembly CG-530/U	1	2	2	1	2	2		1	1		1	1		1	1		1	1		2	2	1			
Power Cable Assembly CX-1209/U																							1		1
Power Cable Assembly CX-1210/U																									1
Bag CW-187/GR																									1
Bag CW-188/GR																									2
Adapter UG-273/U	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2				
Installation kit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1			
Wire W-142	1	1	1										1	1	1	1	1	1							
Adapter UG-306/U	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	1			
Bag CW-206/GR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
Connector and bond nut (Appleton)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						1	



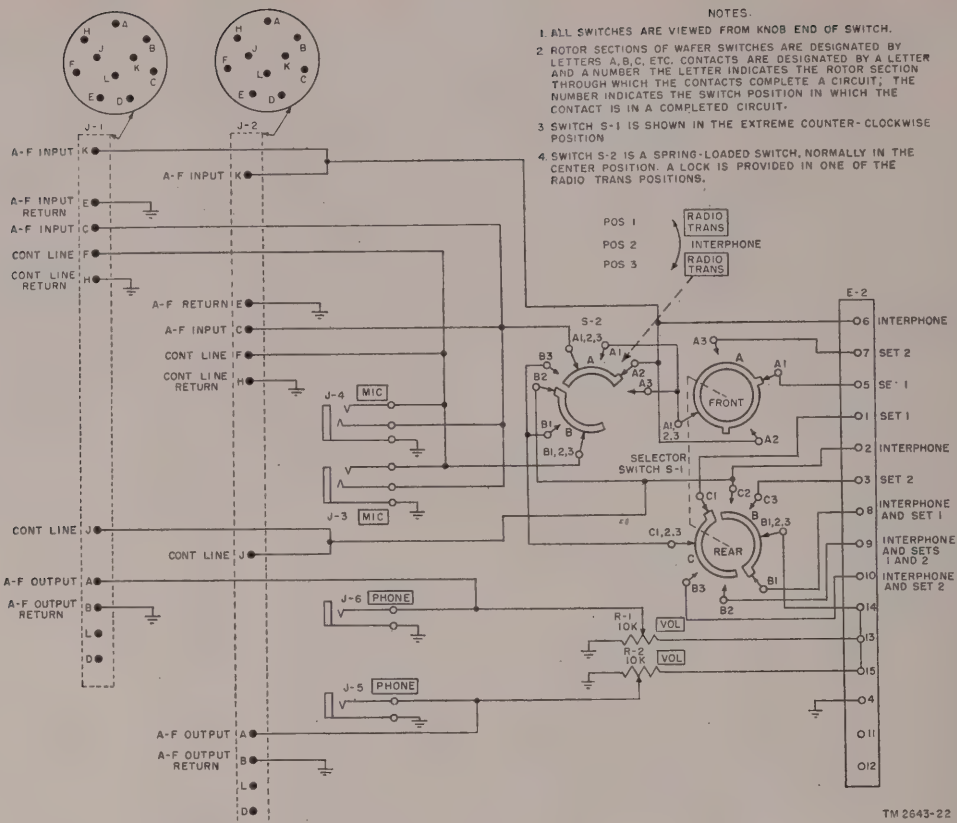


Figure 75. Control Box C-375/VRC, schematic diagram.

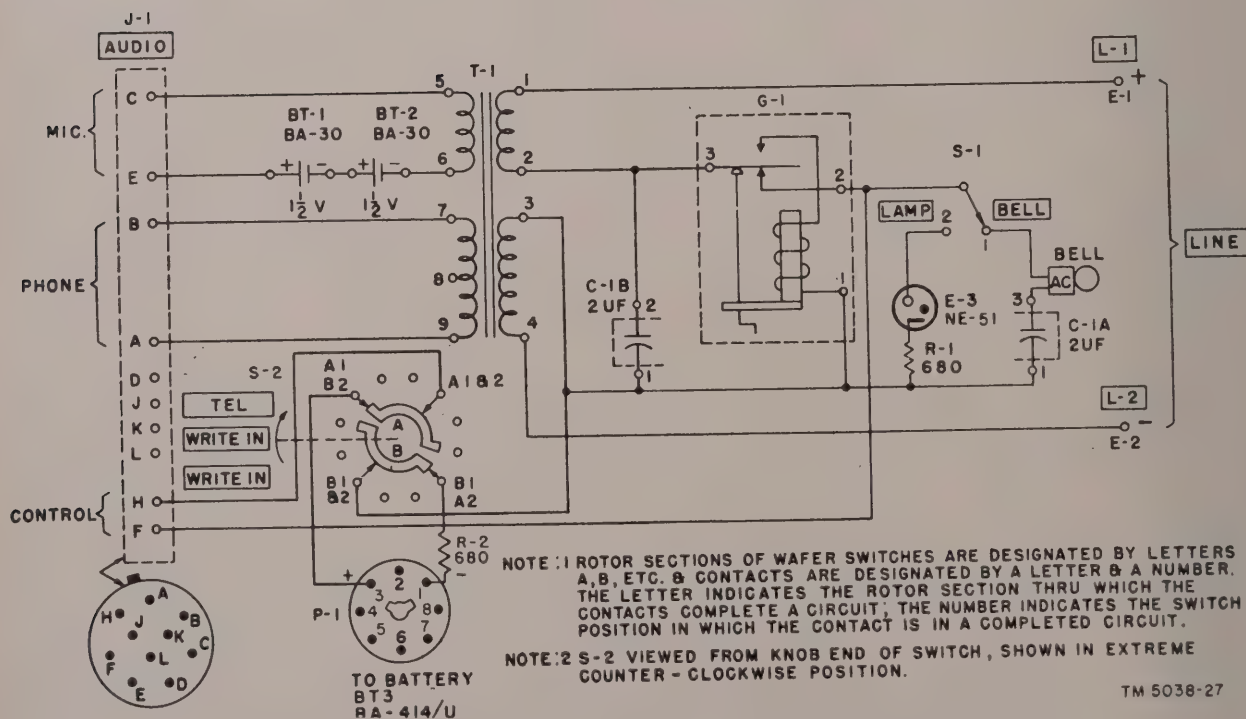


Figure 76. Remote Control C-433/GRC, schematic diagram.

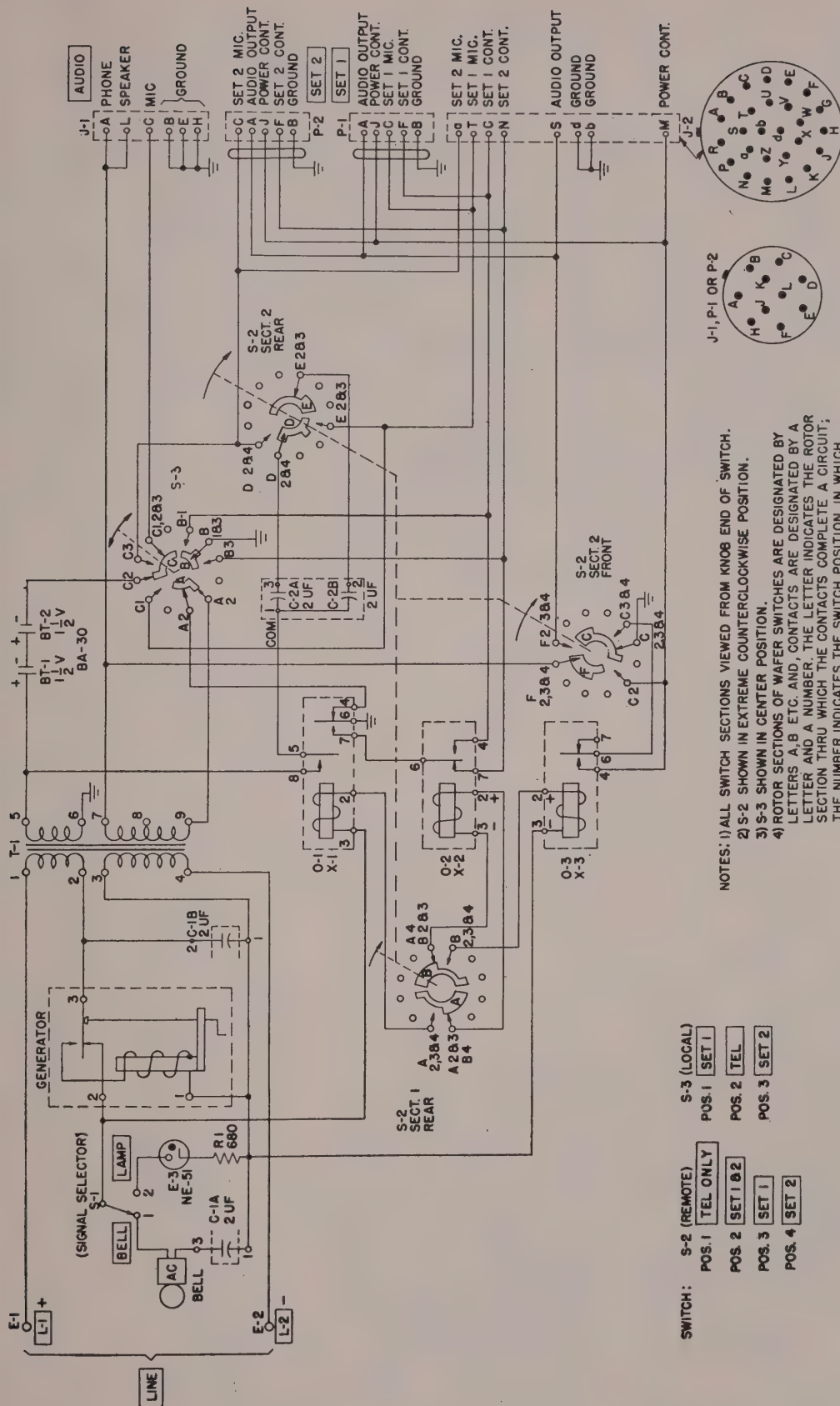


Figure 77. Local Control C-434/GRC, schematic diagram.

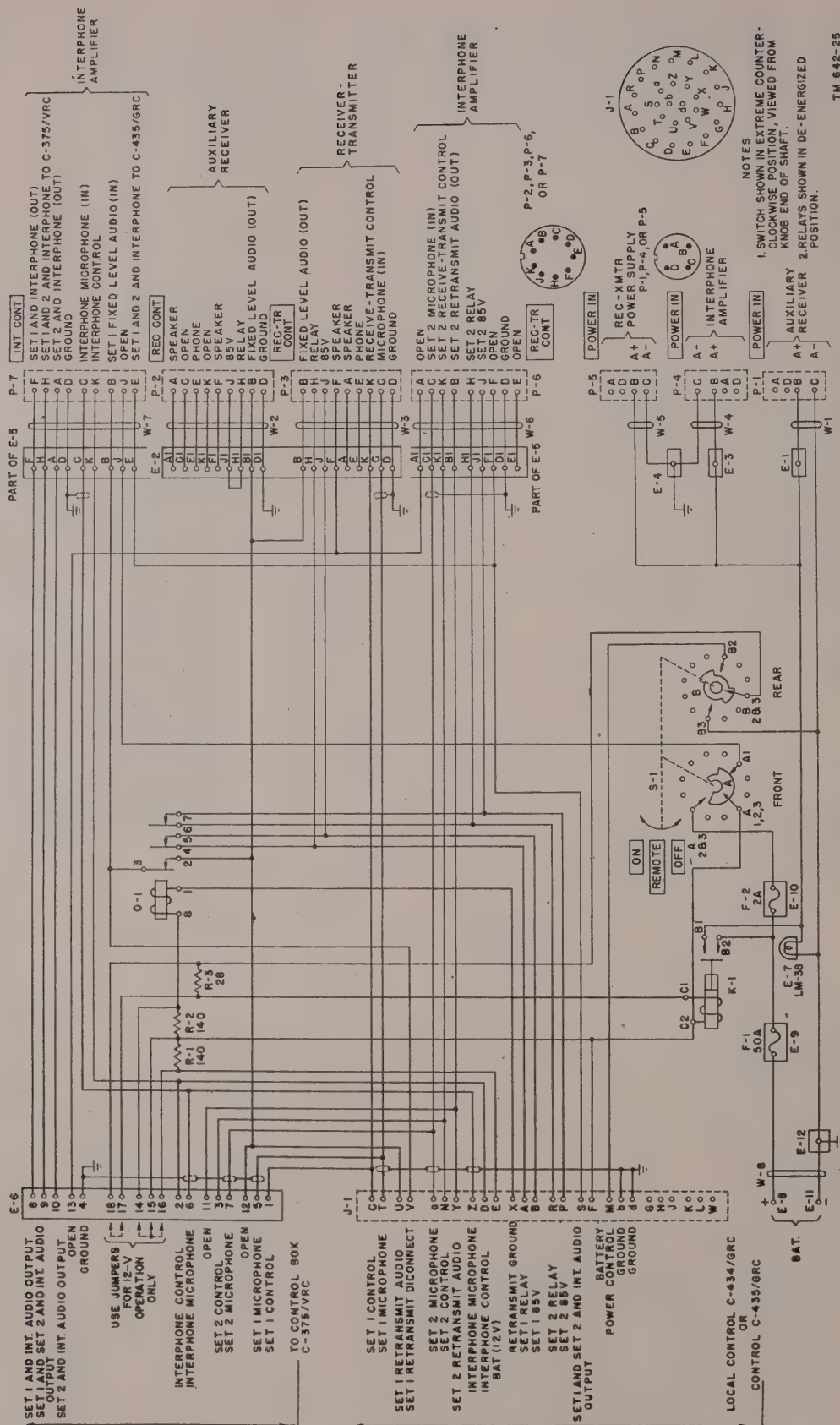
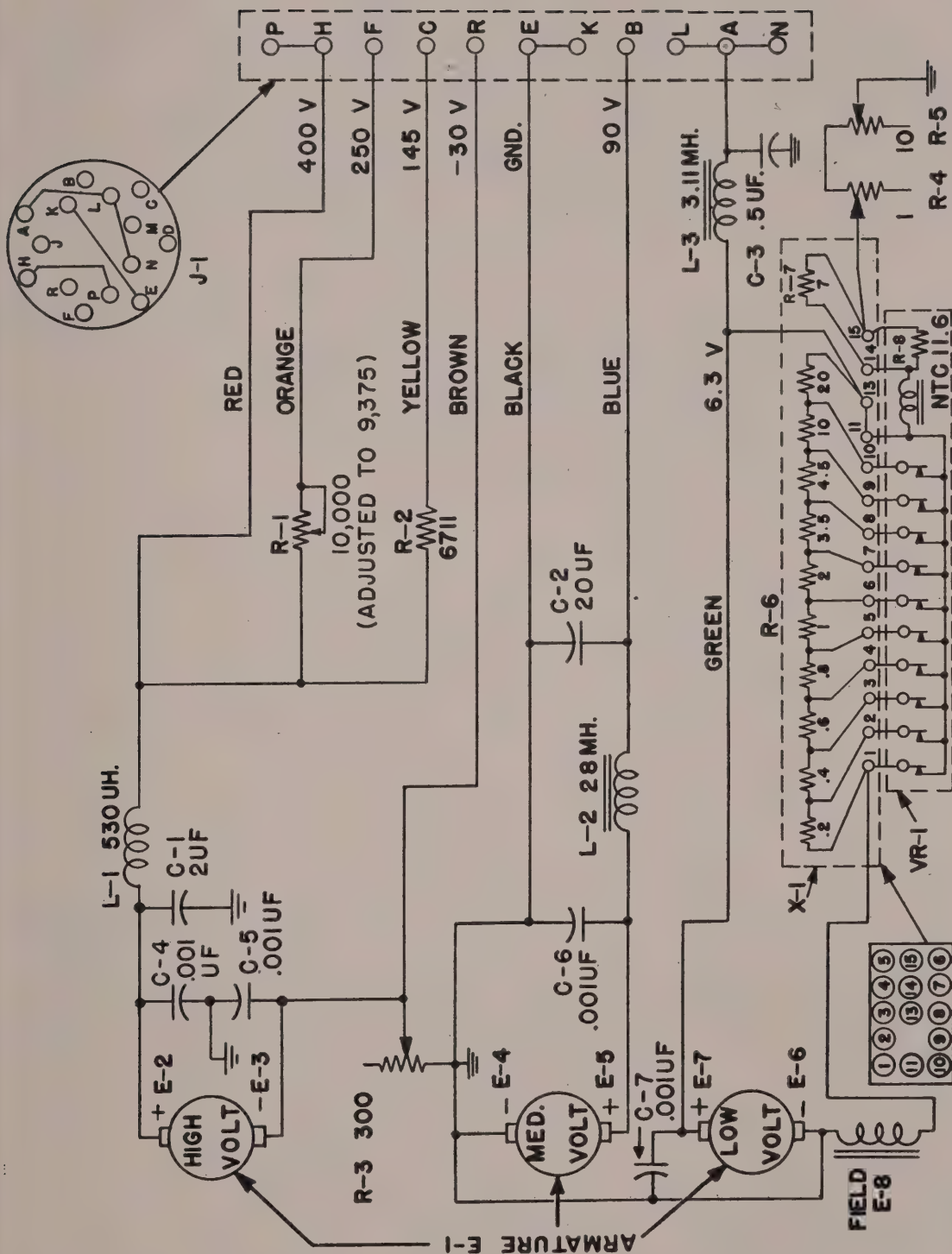


Figure 78. Mounting MT-297/GR, schematic diagram.





NOTE:

ALL RESISTOR VALUES IN OHMS

Figure 79. Generator G-8/GRC, schematic diagram.

TM 5037-13

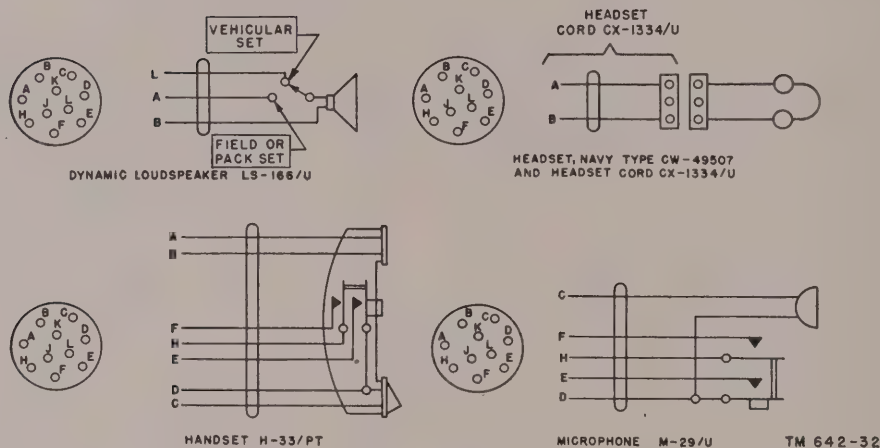
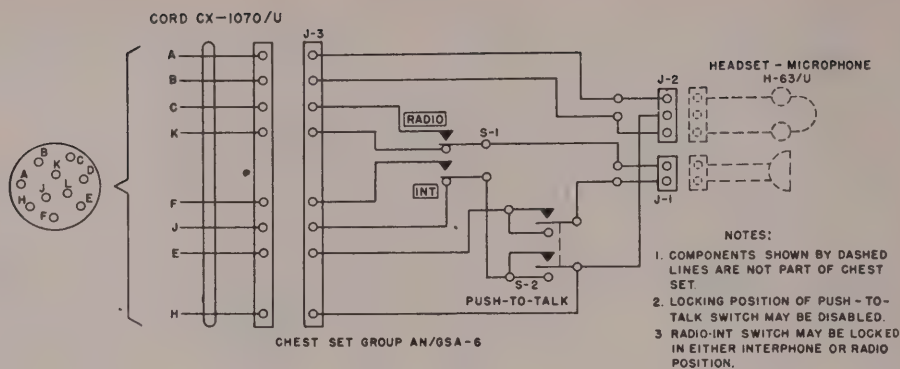


Figure 80. Audio accessories, schematic diagrams.

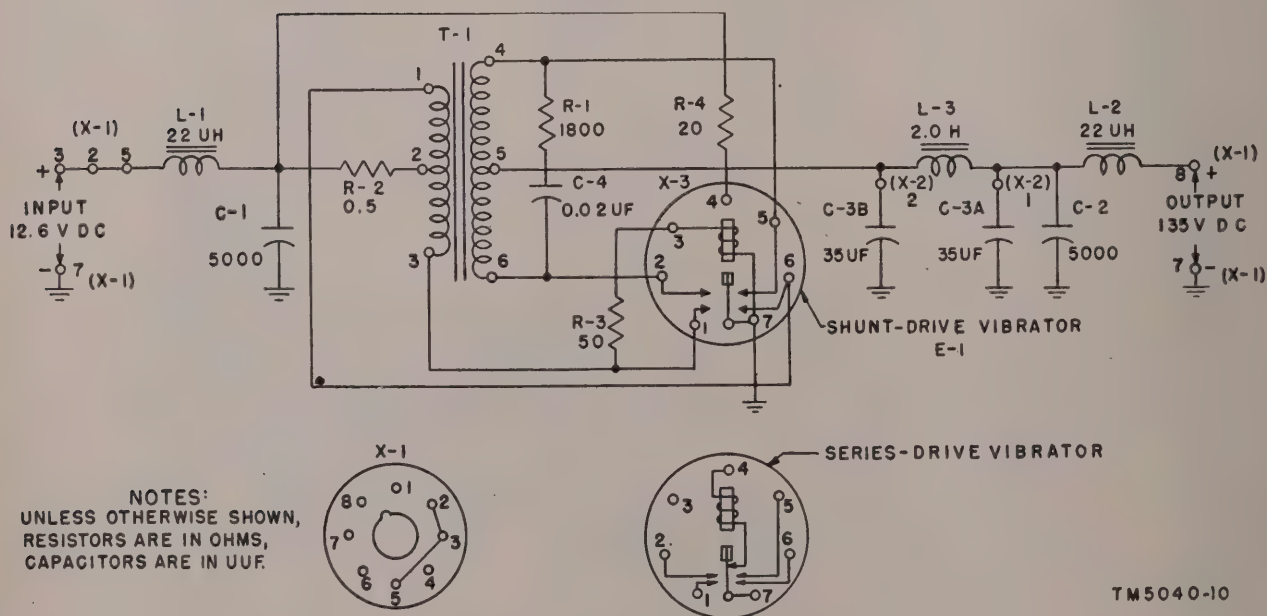


Figure 81. Power Supply PP-281/GRC, schematic diagram.





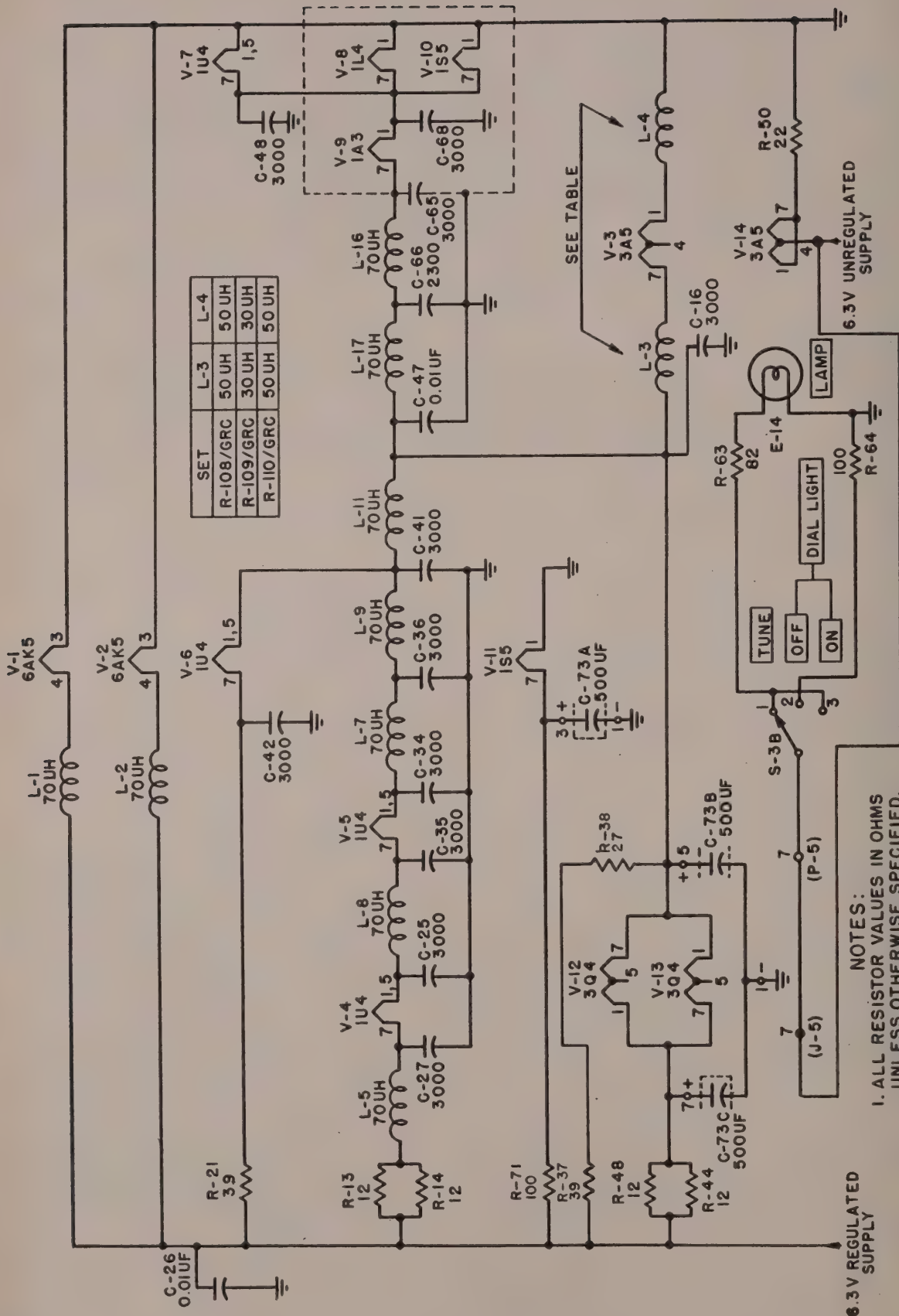
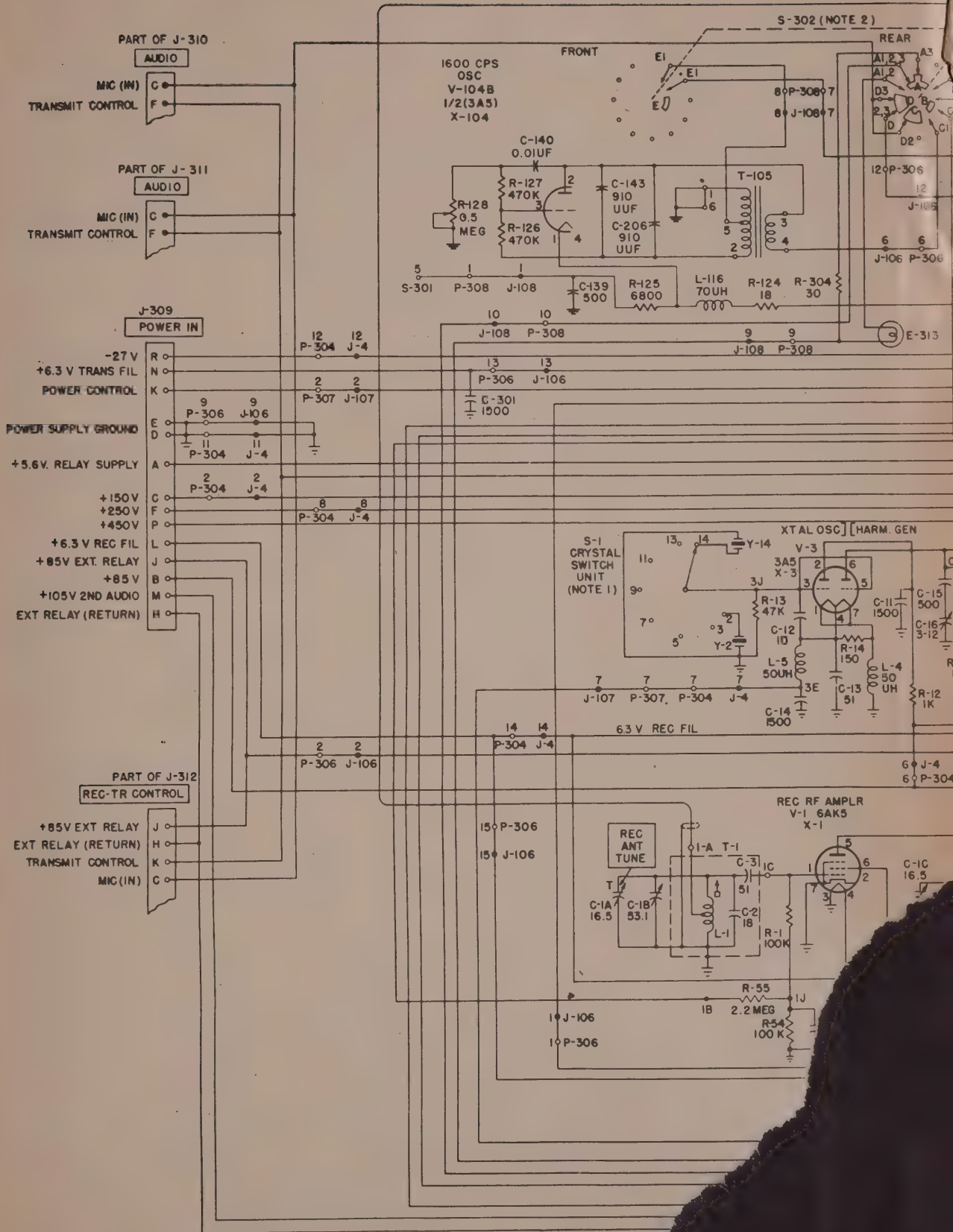


Figure 84. Auxiliary receiver filament circuits.









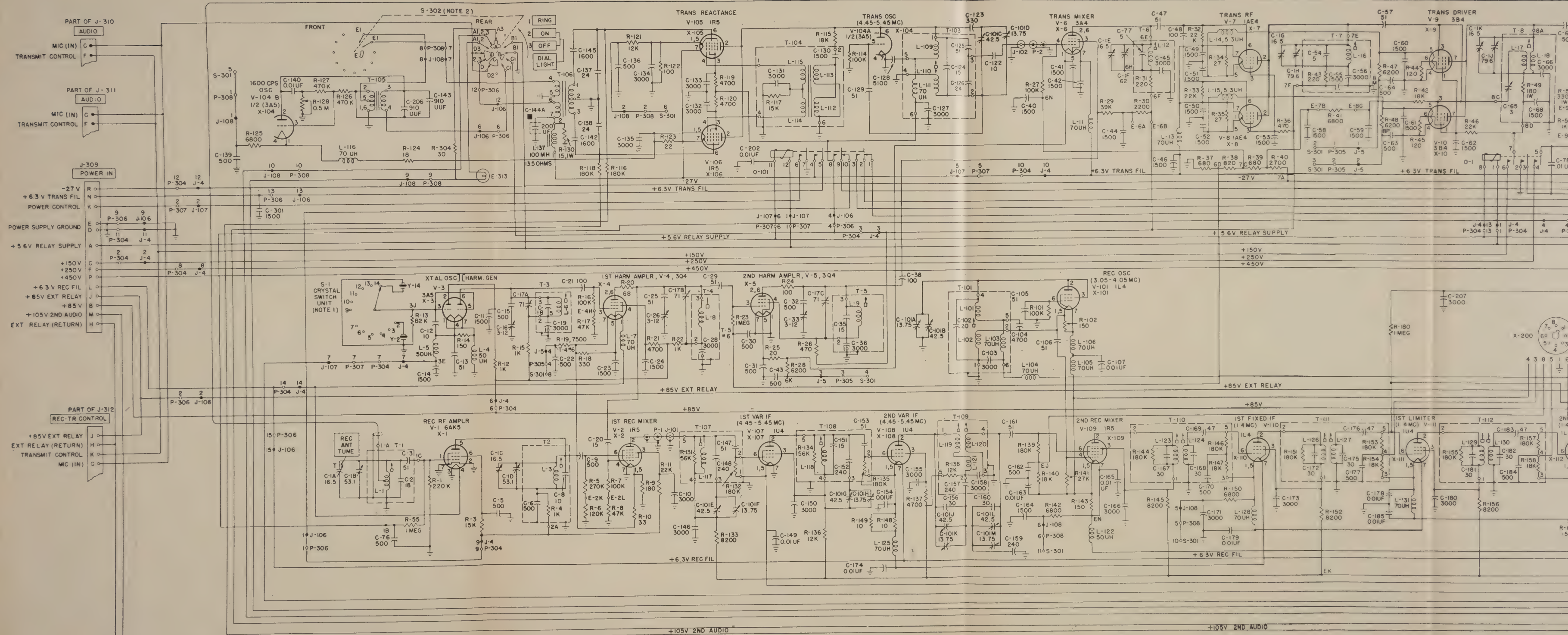
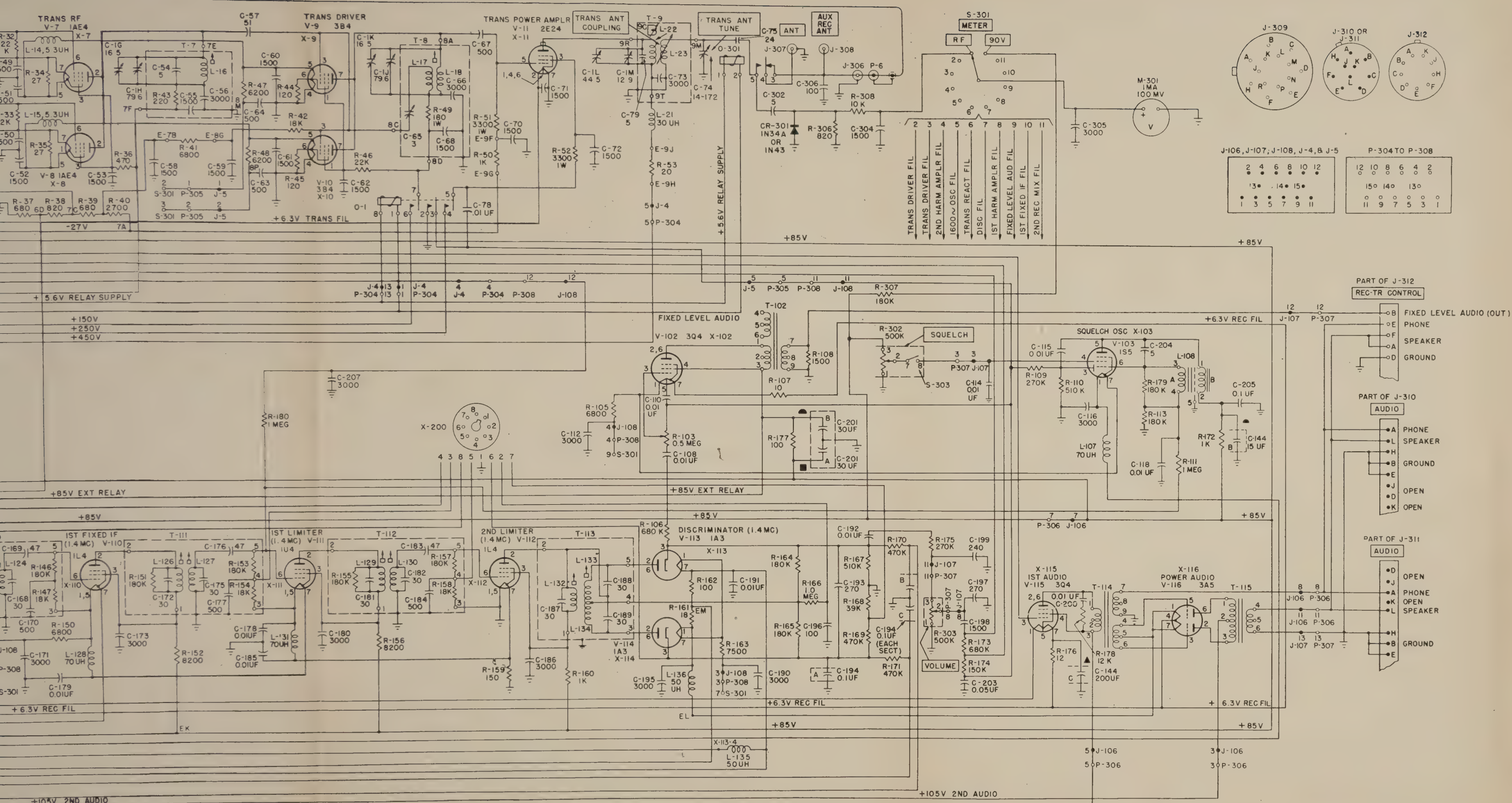


Figure 86. Receiver-Transmitter RT-67/GRC, schematic diagram (later models).





# NOTES

## CRYSTAL SWITCH ASSEMBLY CHART

XTAL POS NOS	CRYSTAL FREQ'S K C
1	
2	7516 666
3	7850 000
4	8183 333
5	8516 666
6	8850 000
7	6887 500
8	
9	7137 500
10	7387 500
11	7637 500
12	7887 500
13	8137 500
14	8387 500
15	
16	
17	

2 SWITCH S-302 IS VIEWED FROM PANEL SIDE AND SHOWN IN OFF POSITION. ROTOR SECTIONS ARE DESIGNATED BY LETTERS A, B, C, ETC., AND CONTACTS ARE DESIGNATED BY A LETTER AND A NUMBER. THE LETTER INDICATES THE ROTOR SECTION THRU WHICH THE CONTACTS COMPLETE A CIRCUIT; THE NUMBER INDICATES THE SWITCH POSITION IN WHICH THE CONTACT IS IN A COMPLETED CIRCUIT.

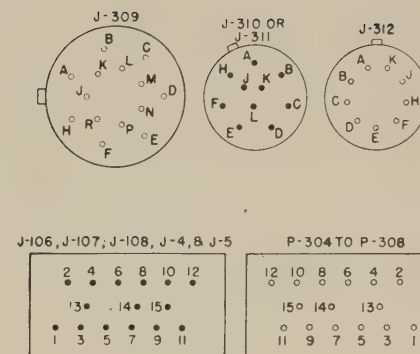
3: UNLESS OTHERWISE SHOWN RESISTORS ARE 1/2 WATT.

4: E-2K, E-2L, E-4H, E-6A, E-6B, E-7B, E-8G, E-9H, AND E-9J ARE TEST POINTS. NUMBER IDENTIFIES CIRCUIT SECTION ASSOCIATED, FOR EXAMPLE, E-2K IS ASSOCIATED WITH V-2; E-4H WITH V-4 ETC. LETTER INDICATES SEQUENCE

5: 1A, 1B THRU 9R ARE TIE POINTS ON RF CHASSIS. NUMBER IDENTIFIES ASSOCIATED CIRCUIT SECTION, LETTER INDICATES SEQUENCE

6: UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF

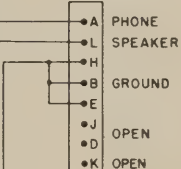
7: THE VARIABLE CAPACITORS WITHIN EACH OF THE FOLLOWING GROUPS ARE GANGED.  
A- C-1B, C-1D, C-1F, C-1G, C-1J  
B- C-17A, C-17B, C-17C  
C- C-101B, C-101C, C-101E, C-101G, C-101I, C-101L



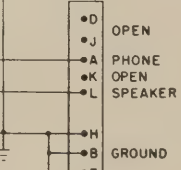
## PART OF J-312 REC-TR CONTROL



## PART OF J-310 AUDIO

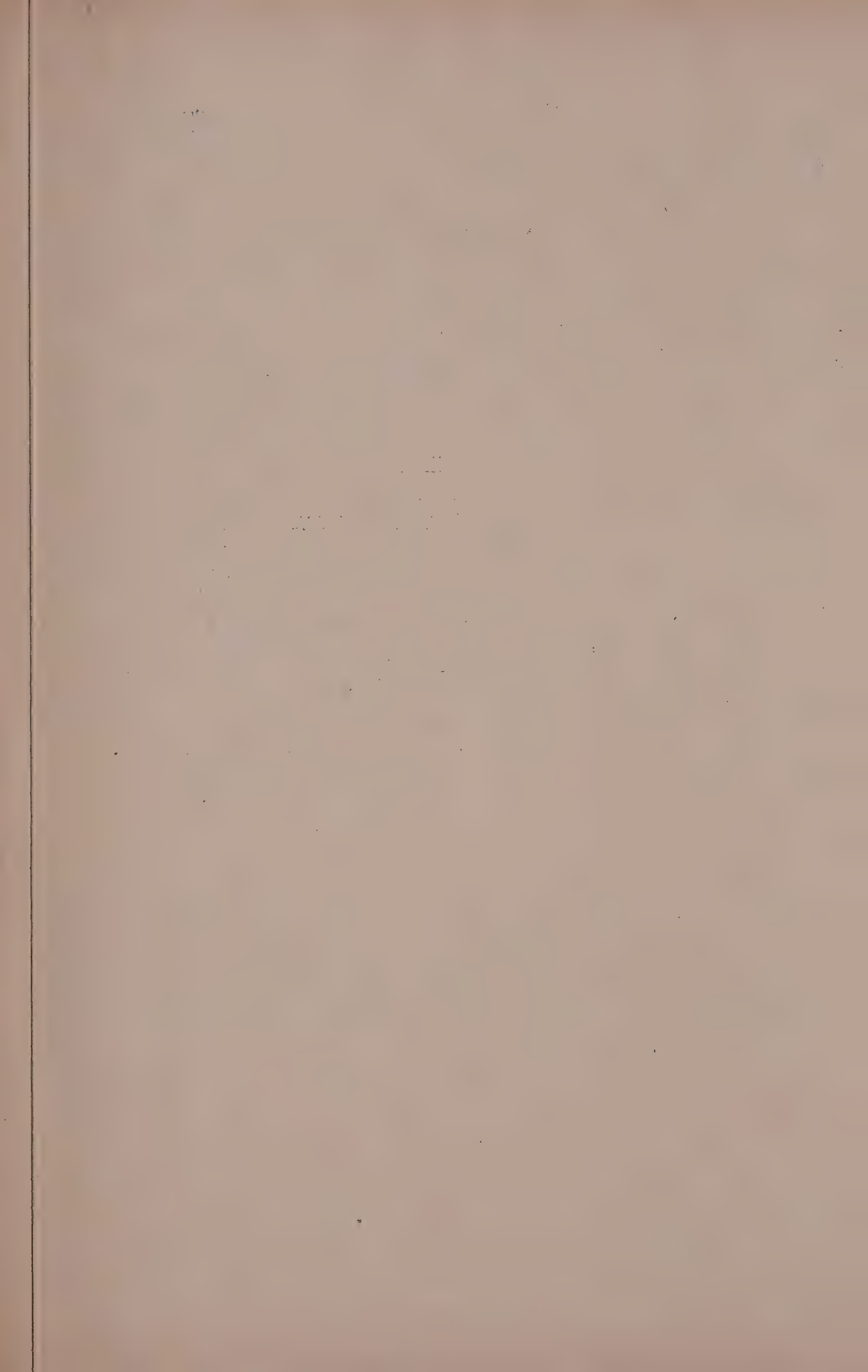


## PART OF J-311 AUDIO









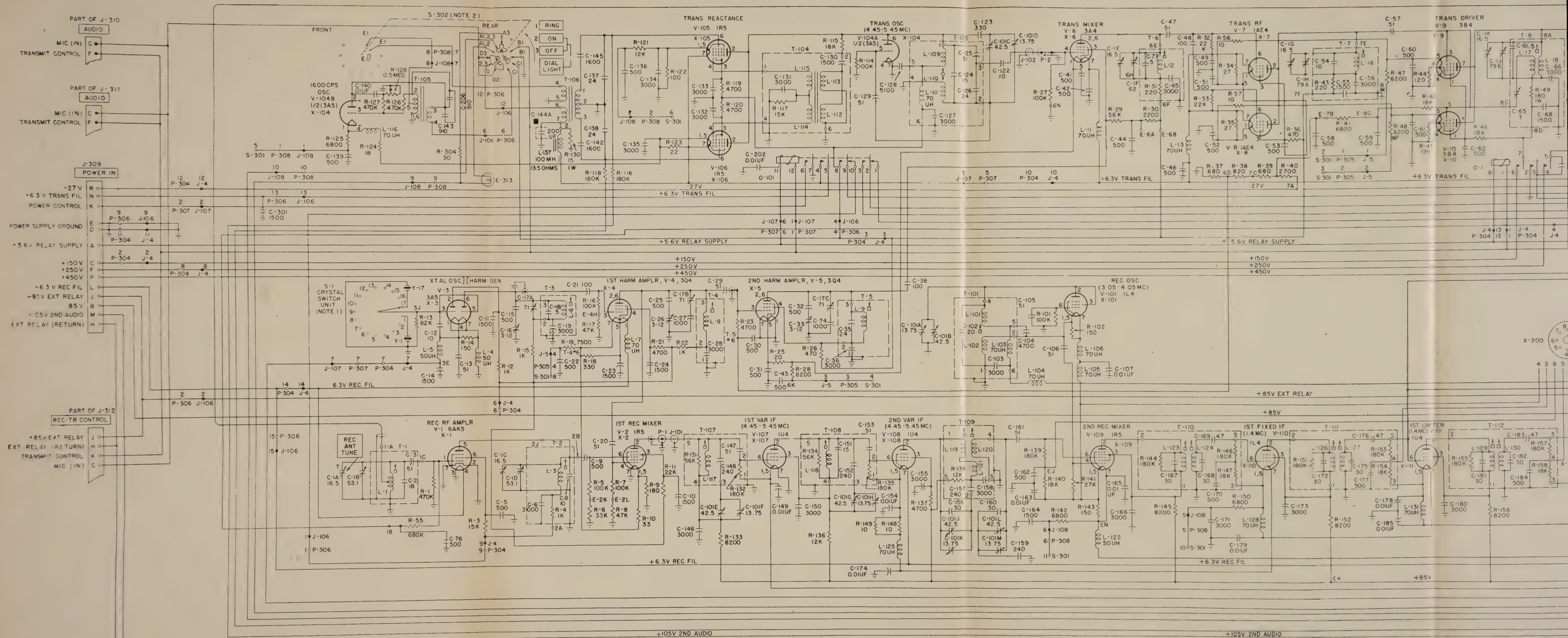
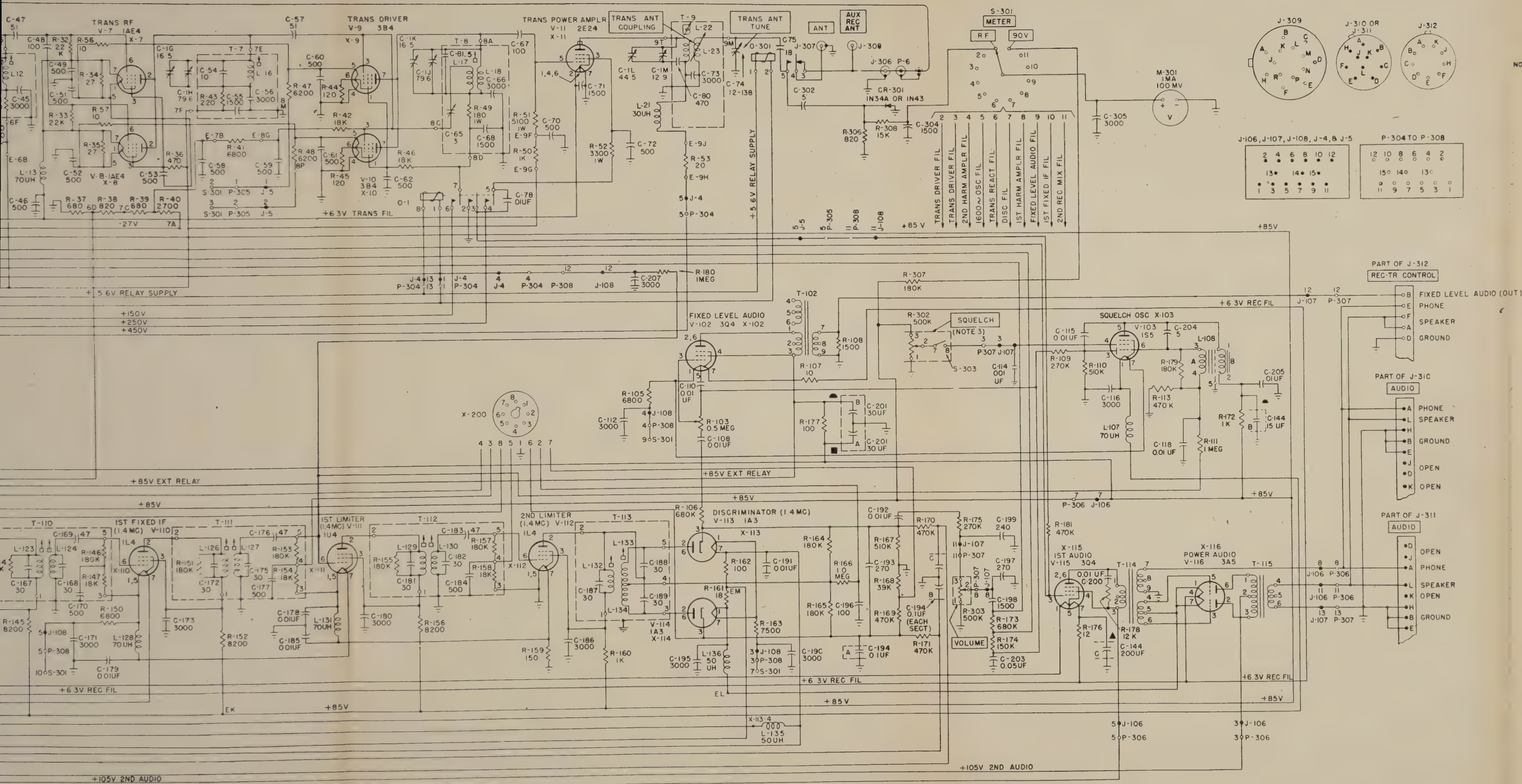


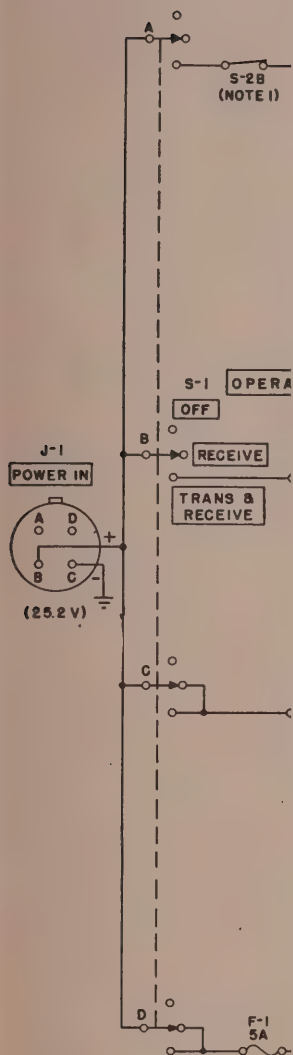
Figure 87. Receiver-Transmitter RT-68/GRC, schematic diagram (later models).





TM 289-CI-45





E-1, E-2, E-3



SERIES-DRIVE VIBRATOR

- NOTE: 1 SWITCH S-2A & S-2B ARE SHOWN IN HIGH-POWER 1 FROM WIRING END. S-2B IN HIGH-POWER POSITION
- NOTE: 2 RELAY O-1 SHOWN IN UNL
- NOTE: 3 UNLESS OTHERWISE SHC ARE IN OHMS, CAPACITOF
- NOTE: 4 ROTOR SECTIONS OF WAF ARE DESIGNATED BY LE CONTACTS ARE DESIGNAT AND A NUMBER. THE LET THE ROTOR SECTION THR CONTACTS COMPLETE A C BER INDICATES THE SWI WHICH THE CONTACT IS I CIRCUIT. THE LETTERS / NOT APPEAR ON THE EQ ARE USED ONLY ON SQ
- NOTE: 5 VOLTAGE READINGS ARE NORMAL LOAD CONDITIO





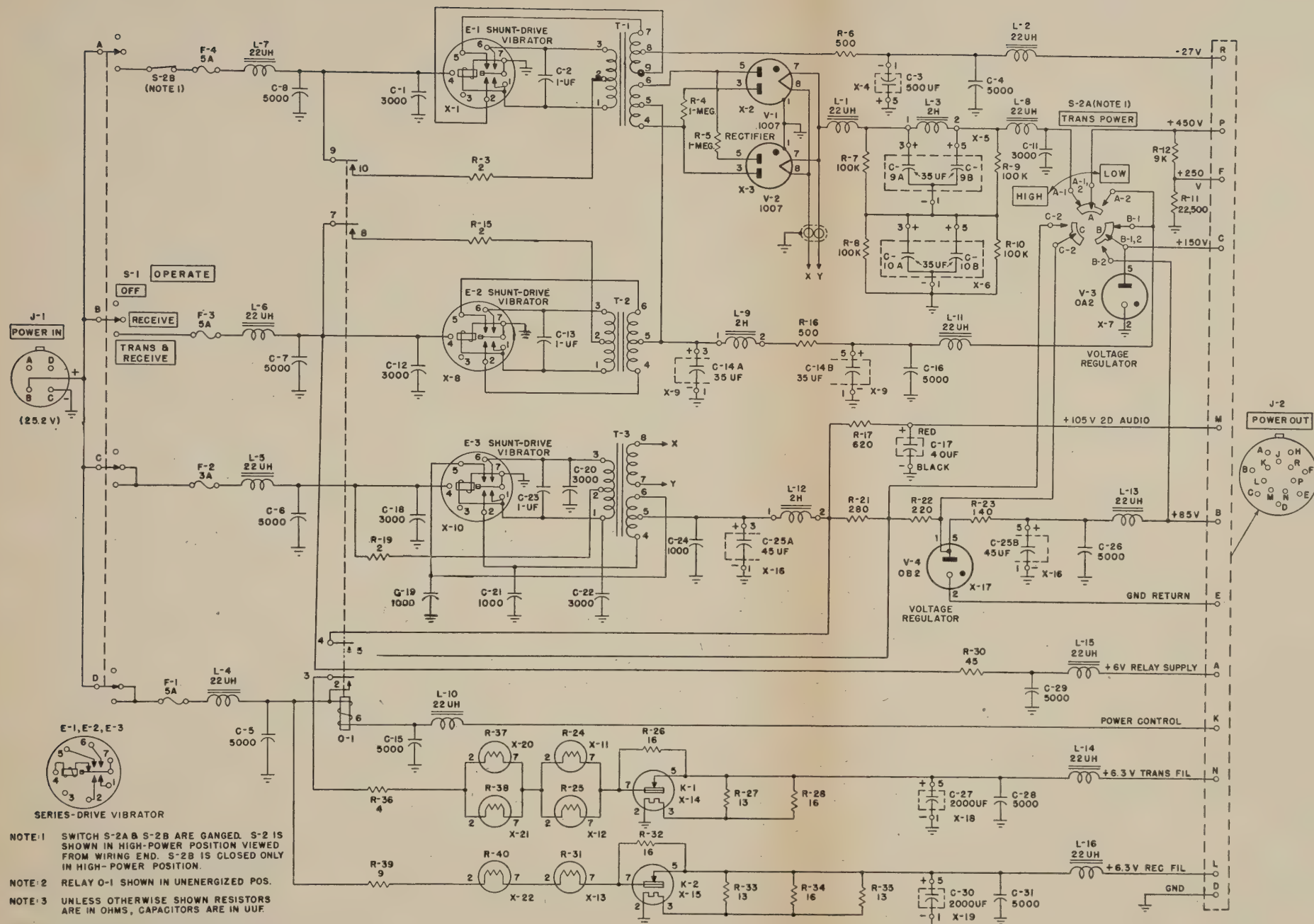
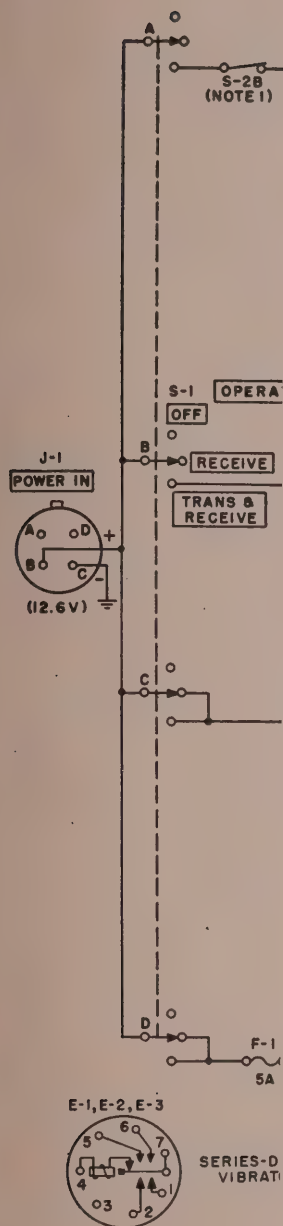


Figure 88. Power Supply PP-112/GR, schematic diagram (later models).







**NOTE 1:** SWITCH S-2A & S-2B A S-2 IS SHOWN IN HI POSITION VIEWED FROM S-2B IS CLOSED ONLY POWER POSITION.

**NOTE 2:** RELAY O-1 SHOWN IN L POSITION.

**NOTE 3:** UNLESS OTHERWISE S ARE IN OHMS, CAPACITORS

**NOTE 4:** ROTOR SECTIONS OF W BY LETTERS A, B, C, ETC. A LETTER AND A NUMBER ROTOR SECTION THROUGH A CIRCUIT; THE NUMBER IN WHICH THE CONTACT LETTERS AND NUMBER BUT ARE USED ONLY (

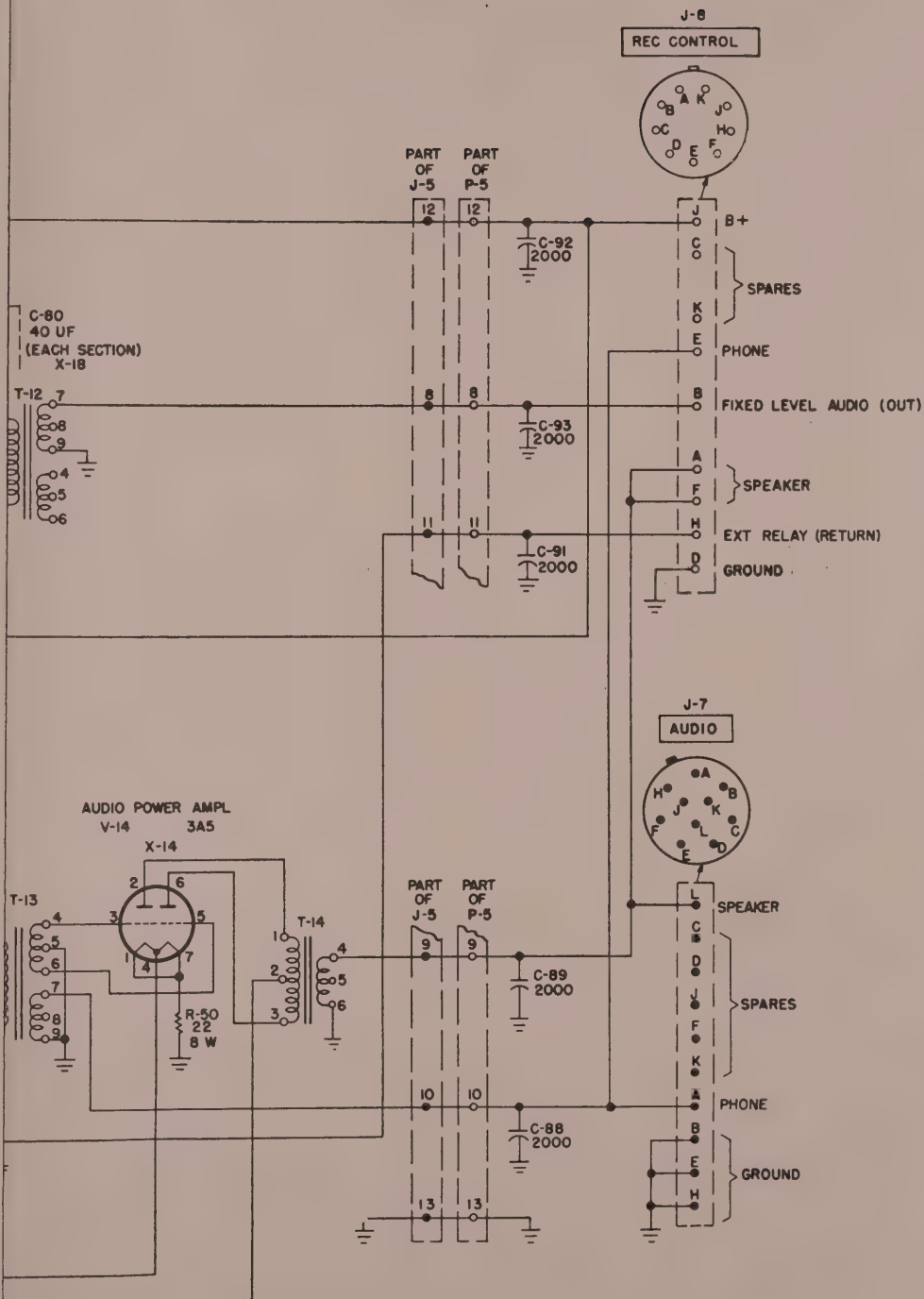
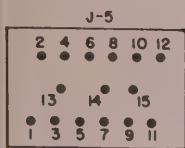
**NOTE 5:** VOLTAGE READINGS ARE















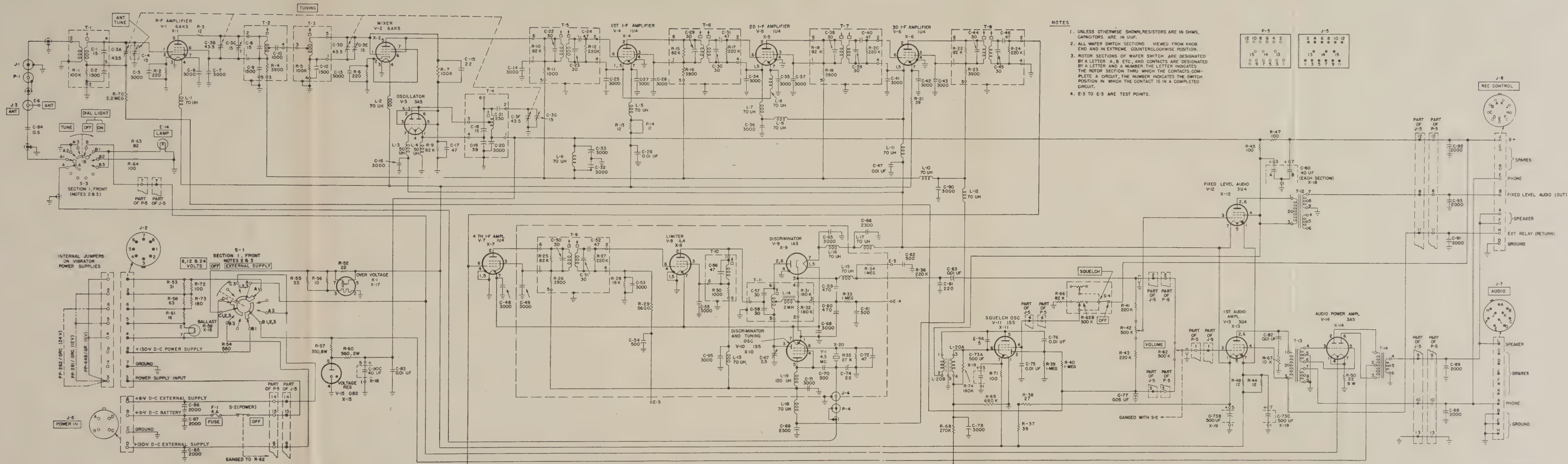


Figure 80. Radio Receiver R-108/GRC, schematic diagram (early models).



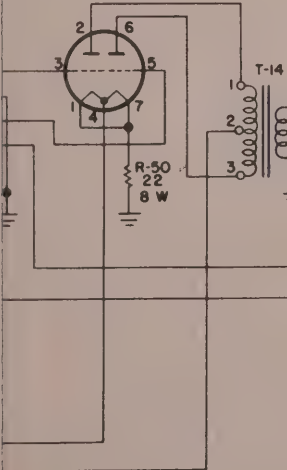
J-5



IF  
SECTION)  
-18

AUDIO POWER AMPL  
V-14 3A5

X-14



PART  
OF  
J-5

PART  
OF  
P-5



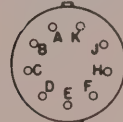
C-92  
2000

C-93  
2000

C-91  
2000

J-8

REC CONTROL



B+

SPARES

PHONE

FIXED LEVEL AUDIO (OUT)

SPEAKER

EXT RELAY (RETURN)

GROUND

J-7

AUDIO



SPEAKER

SPARES

PHONE

GROUND

PART  
OF  
J-5

PART  
OF  
P-5



C-89  
2000

C-88  
2000





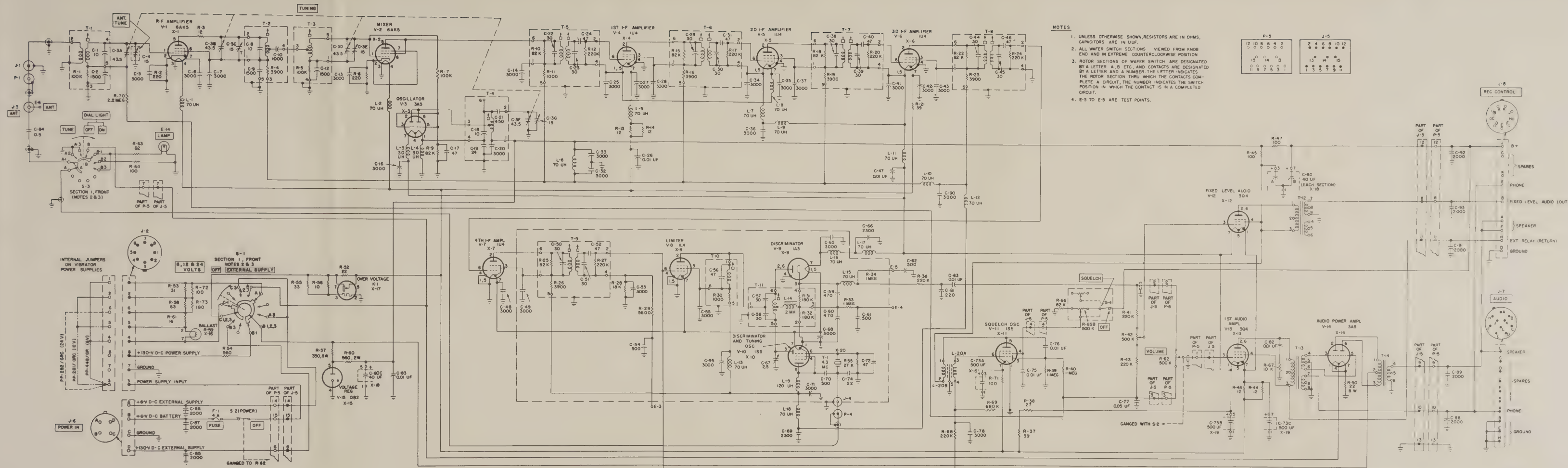


Figure 91. Radio Receiver R-100/GRC, schematic diagram (early models).





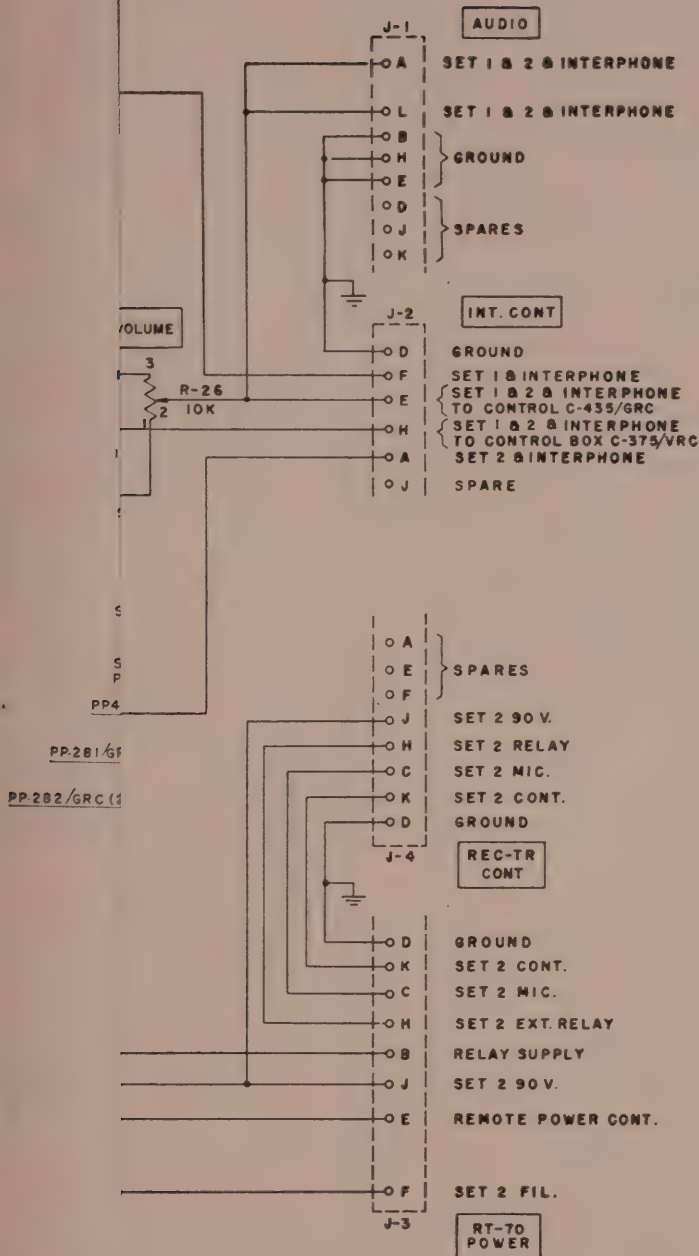












J-1



J-2, J-3, OR J-4







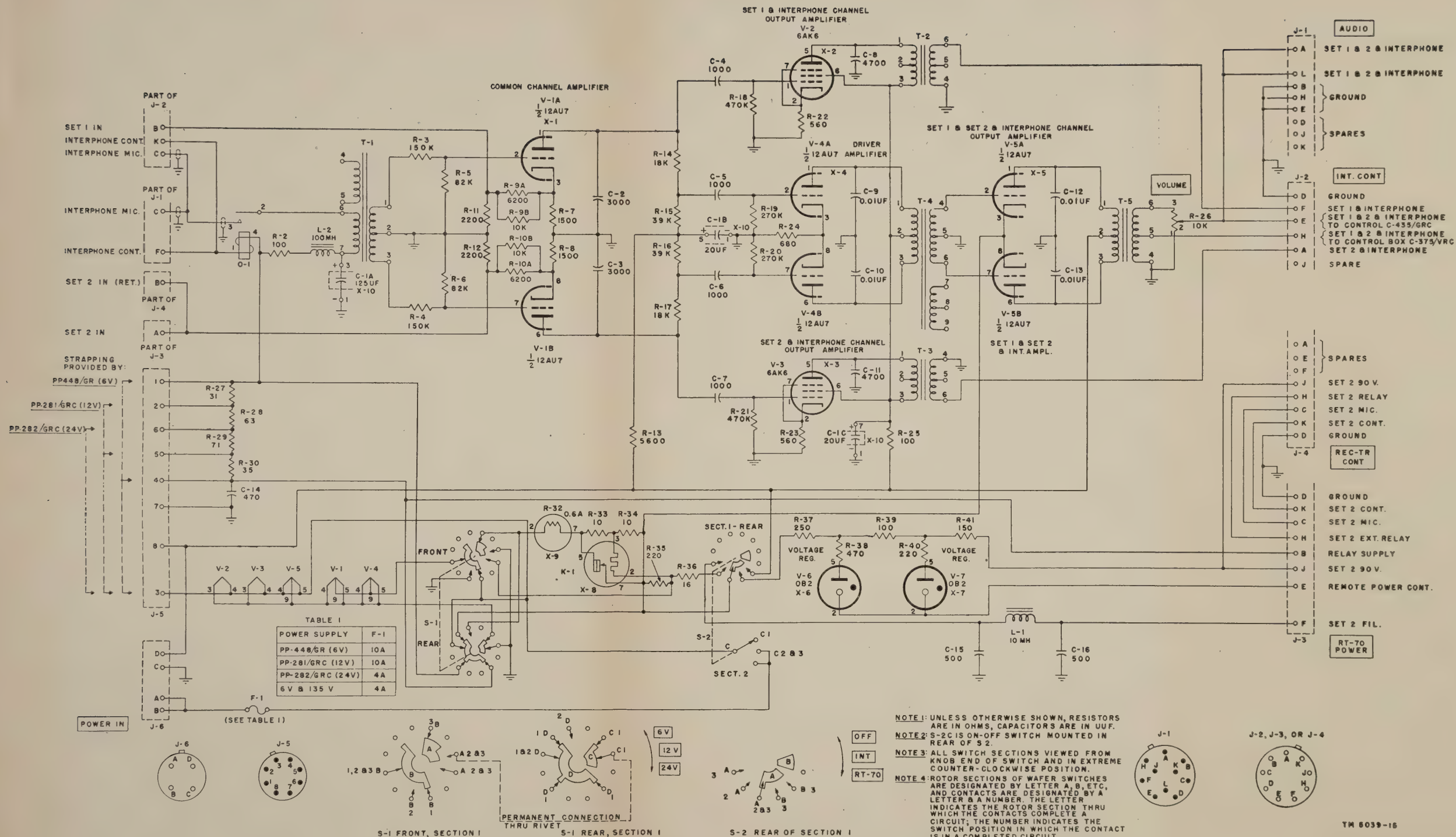


Figure 93. AF Amplifier AM-65/GRC, schematic diagram.







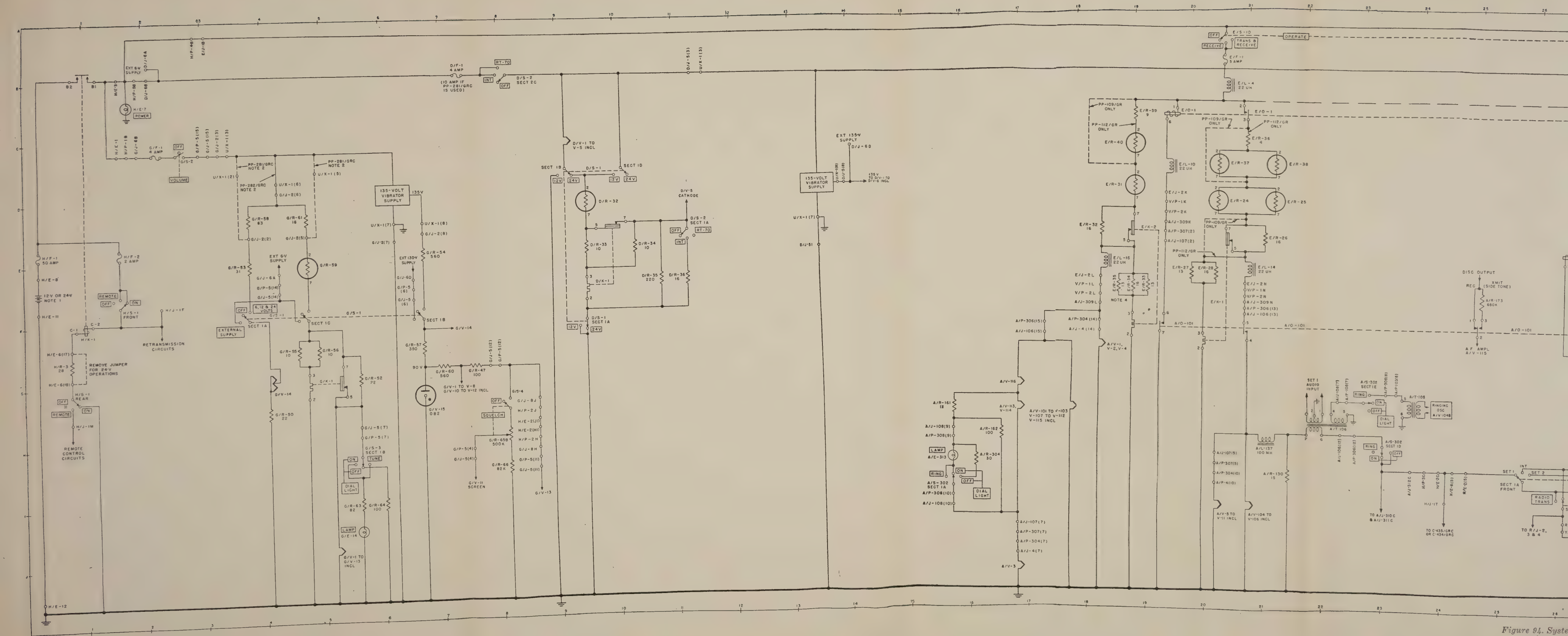
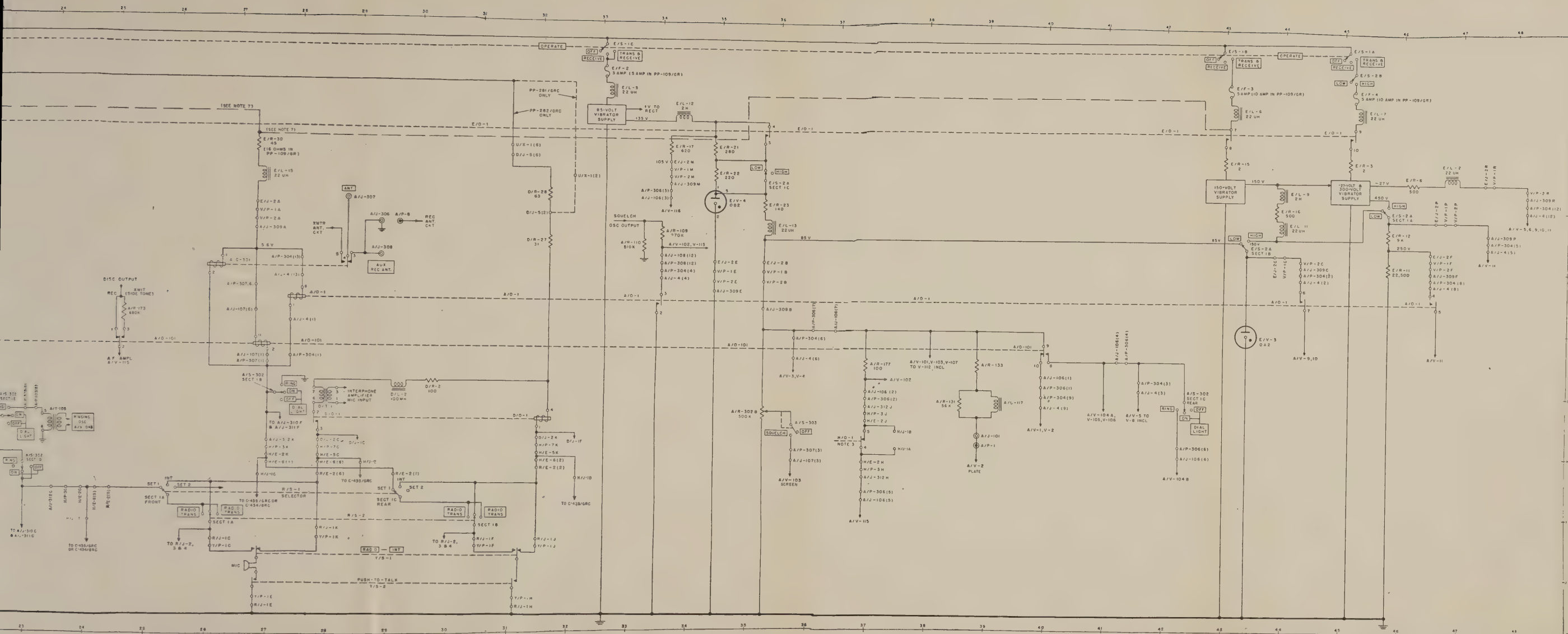



Figure 94. System



		H.P. 1 H.P. 2 H.P. 3
W/P 1 POWER SUPPLY REC.		
A	150V	1.2
W/P 4 POWER SUPPLY		
B	150V	1.3
W/P 5 POWER SUPPLY		
C	150V	1.4
W/P 6 POWER SUPPLY		
D	150V	1.5
W/P 7 POWER SUPPLY		
E	150V	1.6
W/P 8 POWER SUPPLY		
F	150V	1.7
W/P 9 POWER SUPPLY		
G	150V	1.8
W/P 10 POWER SUPPLY		
H	150V	1.9
W/P 11 POWER SUPPLY		
I	150V	2.0
W/P 12 POWER SUPPLY		
J	150V	2.1
W/P 13 POWER SUPPLY		
K	150V	2.2
W/P 14 POWER SUPPLY		
L	150V	2.3
W/P 15 POWER SUPPLY		
M	150V	2.4
W/P 16 POWER SUPPLY		
N	150V	2.5
W/P 17 POWER SUPPLY		
O	150V	2.6
W/P 18 POWER SUPPLY		
P	150V	2.7
W/P 19 POWER SUPPLY		
Q	150V	2.8
W/P 20 POWER SUPPLY		
R	150V	2.9
W/P 21 POWER SUPPLY		
S	150V	3.0
W/P 22 POWER SUPPLY		
T	150V	3.1
W/P 23 POWER SUPPLY		
U	150V	3.2
W/P 24 POWER SUPPLY		
V	150V	3.3
W/P 25 POWER SUPPLY		
W	150V	3.4
W/P 26 POWER SUPPLY		
X	150V	3.5
W/P 27 POWER SUPPLY		
Y	150V	3.6
W/P 28 POWER SUPPLY		
Z	150V	3.7

UNIT SYMBOL		PART SYMBOL		TERMINAL SYMBOL		UNIT SYMBOL		PART SYMBOL		TERMINAL SYMBOL		UNIT SYMBOL		PART SYMBOL		TERMINAL SYMBOL	
A	RECEIVER-TRANSMITTER	B	RECEIVER-TRANSMITTER	C	RECEIVER-TRANSMITTER	D	RECEIVER-TRANSMITTER	E	RECEIVER-TRANSMITTER	F	RECEIVER-TRANSMITTER	G	RECEIVER-TRANSMITTER	H	RECEIVER-TRANSMITTER	I	RECEIVER-TRANSMITTER

- NOTES
1. VEHICLE MAY HAVE EITHER 12- OR 24- VOLT BATTERY.
  2. THE AUXILIARY RECEIVER AND INTERPHONE AMPLIFIER USE EITHER POWER SUPPLY PP-105/GR OR PP-105/GR-1, DEPENDING ON WHETHER A 12- OR 24- VOLT BATTERY IS USED.
  3. RELAY RTD-1 IS OPERATIVE ONLY WHEN CONTROL C-434/GR IS USED.
  4. RELAYS E/R-33, 34, AND 35 CONNECT BETWEEN PINS 2 AND 3 OF E/R-2 IN POWER SUPPLY PP-105/GR BETWEEN PINS 2 AND 3 OF E/R-2 IN POWER SUPPLY PP-105/GR-1.
  5. SET 1 REFERS TO RECEIVER-TRANSMITTER RT-66, 67, OR 68.
  6. SET 2 REFERS TO A SECOND RECEIVER-TRANSMITTER SUCH AS THE RT-70/GR WHICH CAN BE USED WITH THESE RADIO SETS (SEE T-111/284).
  7. IN SOME MODELS OF PP-105/GR AND PP-105/GR-1, E/R-30 IS CONNECTED TO TERMINAL 2 OF E/R-1. IN OTHER MODELS, E/R-30 IS CONNECTED TO TERMINAL 7 OF E/R-1.

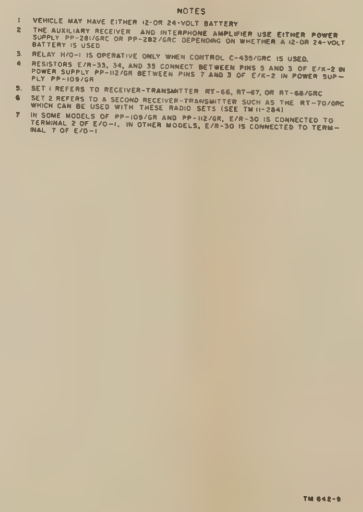
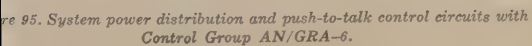
Figure 94. System power distribution and push-to-talk control circuits with Control Box C-375/VRC.





A  
B  
C  
D  
E  
F  
G  
H  
I  
J  
K









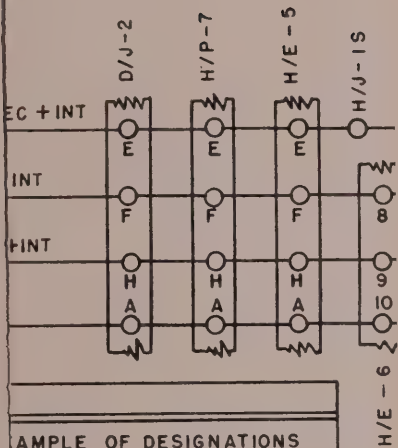
N/S-2  
SECT 2F  
FRONT

SET 1  
SET 1 & 2

S

ER

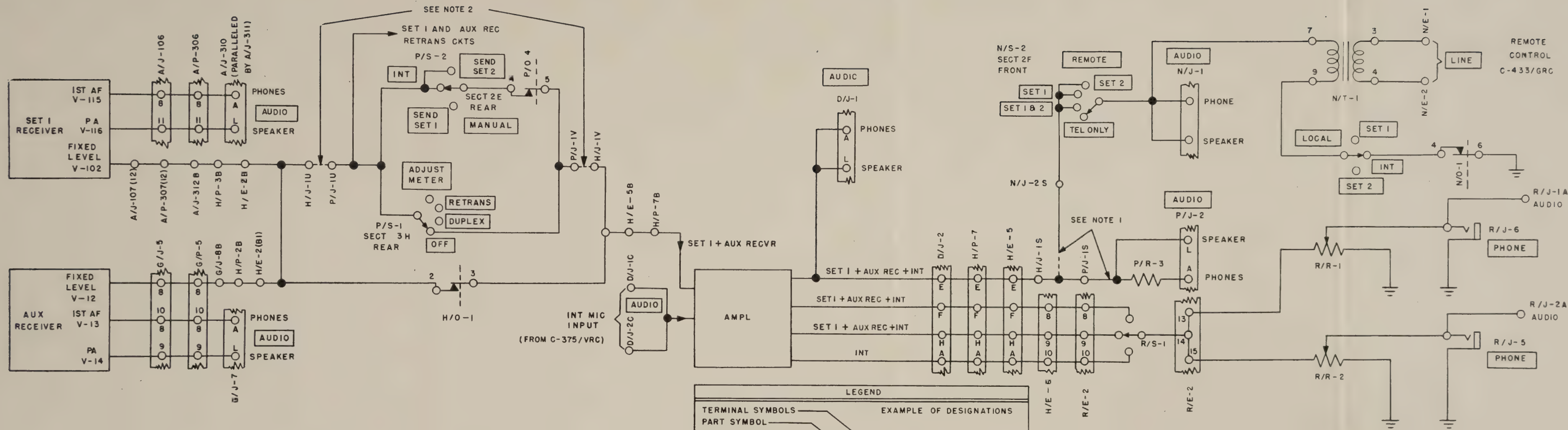
N/J-2 S



AMPLE OF DESIGNATIONS	
B	(13)
2	
SYMBOLIZED	
RT-67/GRC, RT-68/GRC	
HONE AMPLIFIER)	
GRC, OR R-110/GRC	
SION UNIT)	
213/U	







LEGEND	
TERMINAL SYMBOLS	EXAMPLE OF DESIGNATIONS
PART SYMBOL	
UNIT SYMBOL	
	<div> <div>H</div> <div>F-1</div> <div>D</div> <div>J-6</div> <div>G</div> <div>P-202</div> <div>B</div> <div>I13</div> </div>
UNIT SYMBOL AND UNIT SYMBOLIZED	
A	RECEIVER-TRANSMITTER RT-66/GRC, RT-67/GRC, RT-68/GRC
D	AF AMPLIFIER AM-65/GRC (INTERPHONE AMPLIFIER)
G	RADIO RECEIVER R-108/GRC, R-109/GRC, OR R-110/GRC
H	MOUNTING MT-297/GR
N	LOCAL CONTROL C-434/GRC
P	CONTROL C-435/GRC (RETRANSMISSION UNIT)
R	CONTROL BOX C-375/VRC
W	SPECIAL PURPOSE CABLE ASSEMBLY CX-1213/U

- NOTES
- 1 THE DASHED LINE INDICATES HOW THE LOCAL CONTROL C-434/GRC CONNECTS WHEN SLID INTO MOUNTING, THE SOLID LINE SHOWS THE CORRESPONDING CONNECTION FOR CONTROL C-435/GRC.
  - 2 DASHED LINES INDICATE CONNECTIONS WHEN CONTROL C-435/GRC IS USED

Figure 96. System monitoring circuits.







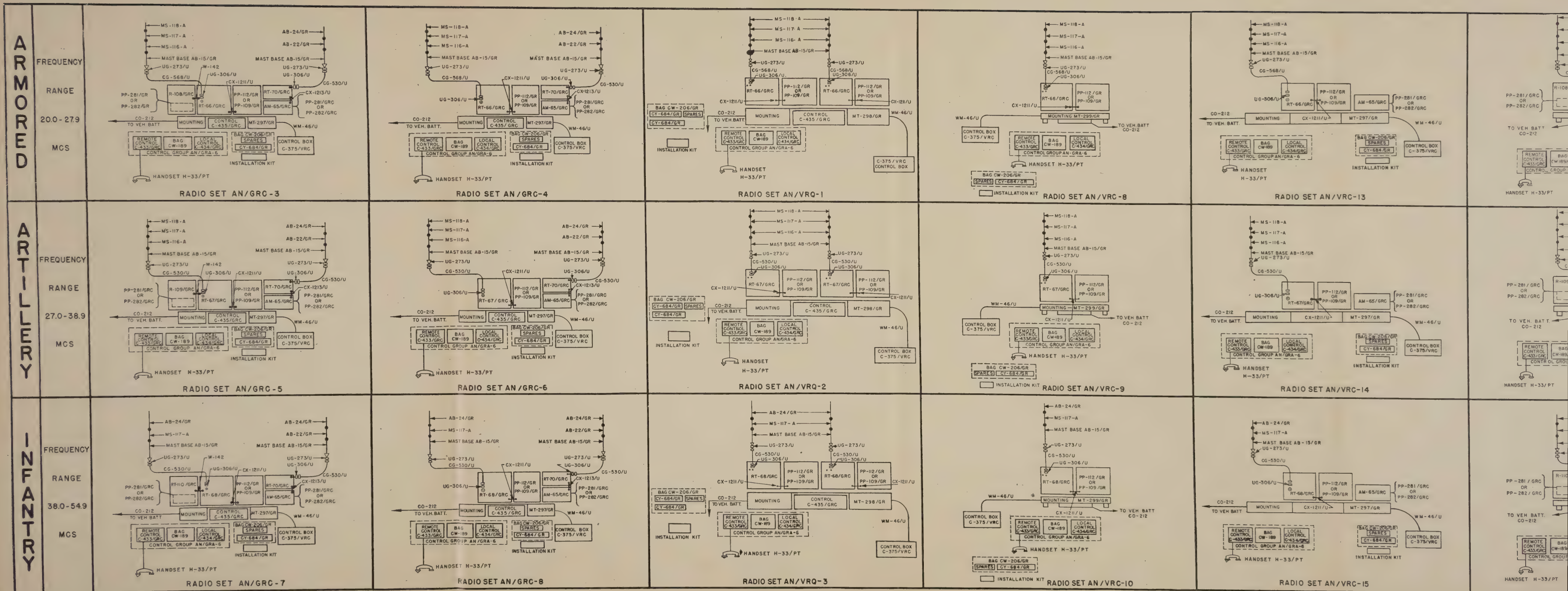


Figure 97. Installations of related f-m radio sets.



# ARMORED ARTILLERY AND INFANTRY

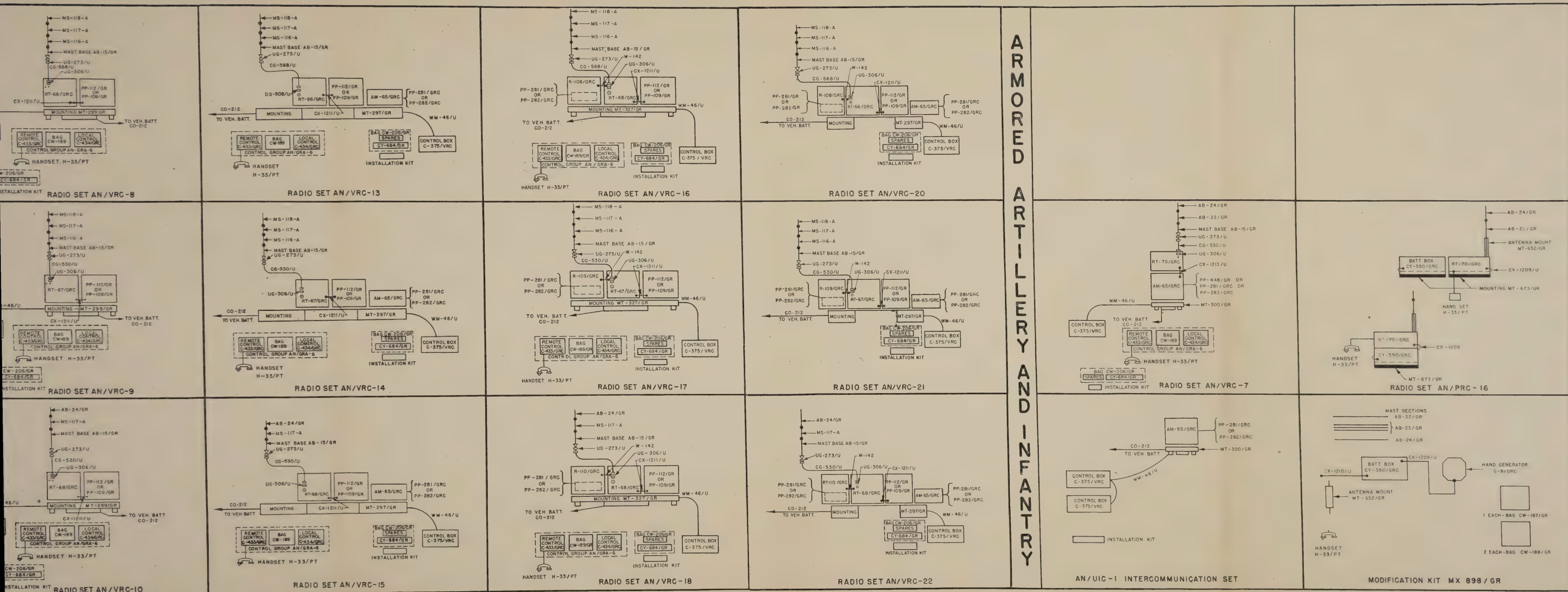


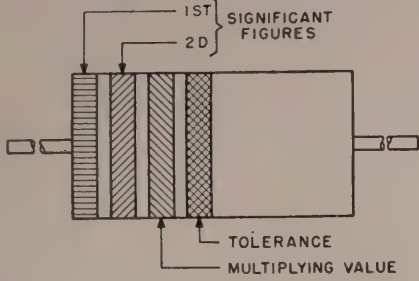
Figure 97. Installations of related f-m radio sets.



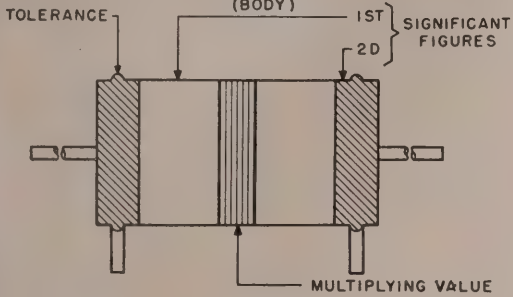


# RESISTOR COLOR AND LETTER CODE

## RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

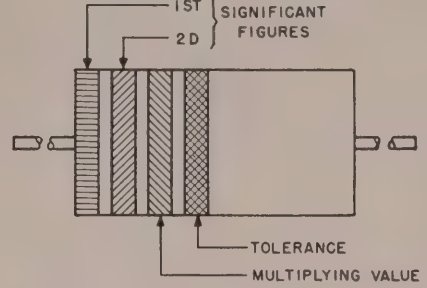


### METHOD A

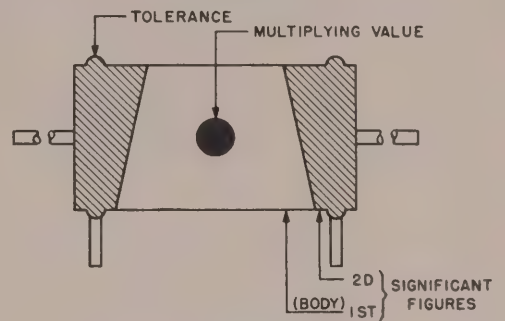


### METHOD B

## JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

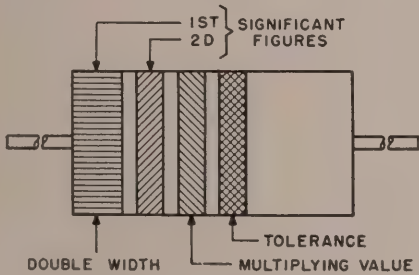


### METHOD A

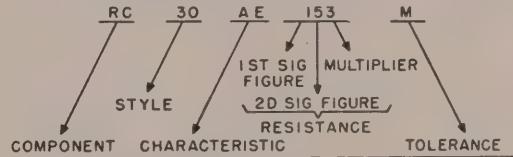


### METHOD B

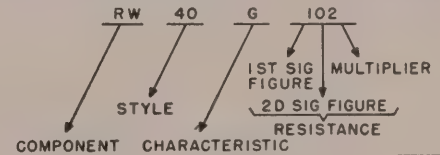
## JAN COLOR CODE (FIXED, WIRE-WOUND: RU)



## JAN TYPE DESIGNATIONS (FIXED COMPOSITION)



## JAN TYPE DESIGNATIONS (FIXED, WIRE-WOUND)



## STANDARDS

COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	—	—
BROWN	1	10	± 1	F
RED	2	100	± 2	G
ORANGE	3	1,000	± 3	—
YELLOW	4	10,000	± 4	—
GREEN	5	100,000	± 5	—
BLUE	6	1,000,000	± 6	—
VIOLET	7	10,000,000	± 7	—
GRAY	8	100,000,000	± 8	—
WHITE	9	1,000,000,000	± 9	—
GOLD	—	0.1	± 5	J
SILVER	—	0.01	± 10	K
NO COLOR	—	—	± 20	M

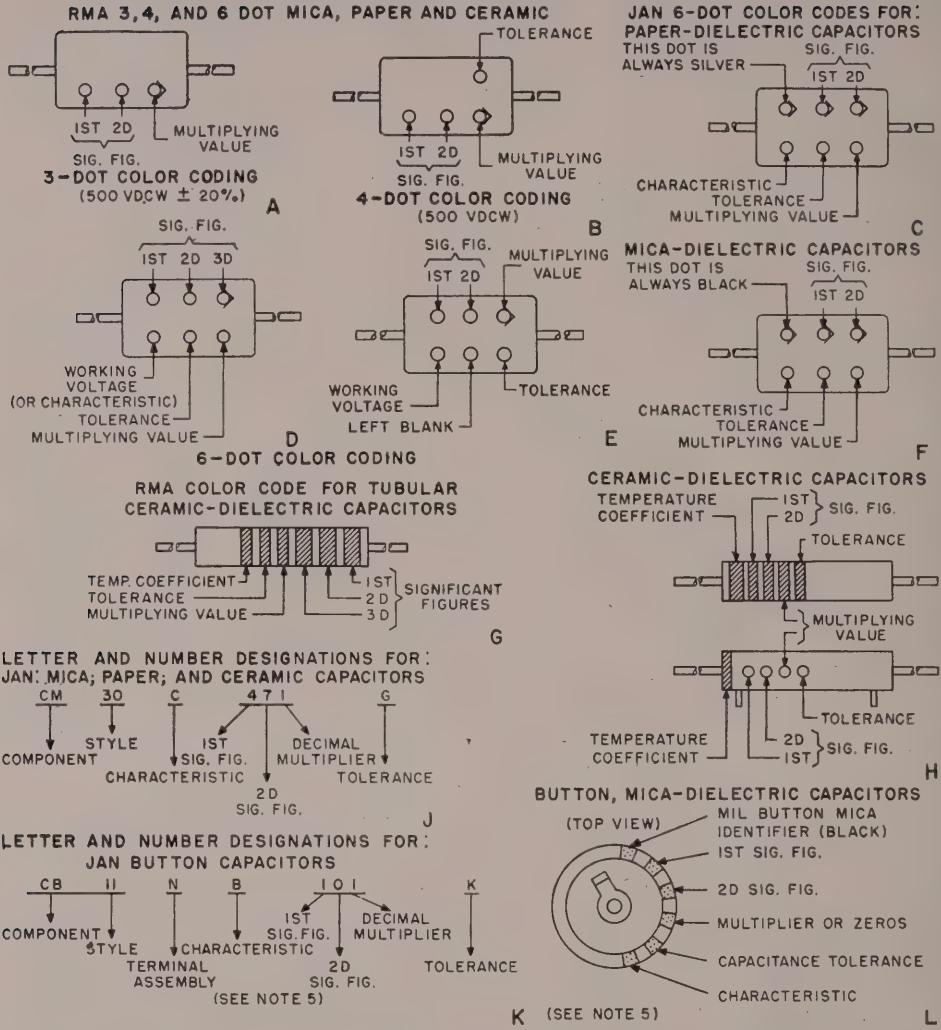
## NOTES:

1. RESISTORS WITH AXIAL LEADS ARE INSULATED. RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY - NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TMRC.

Figure 98. Resistor color and letter code.

# CAPACITOR COLOR AND LETTER CODES



- STANDARDS -					JAN MICA-CM		JAN PAPER-CP		JAN CERAMIC-CC					
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARACTERISTIC	LETTER TOL.	CHARACTERISTIC	DEC. MULT.	CAP.TOL.FOR MORE THAN 10 UUF		CAP.TOL.FOR 10 UUF OR LESS		CHARACTERISTIC
										%	LETTER DESIGNATION	UUF	LETTER DESIGNATION	
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	±1	100	-	B	-	E	10	±1	F	-	-	H
RED	2	100	±2	200	G	C	-	H	100	±2	G	-	-	L
ORANGE	3	1,000	±3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	±4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	±5	500	-	F	-	R	-	±5	J	±0.5	D	S
BLUE	6	1,000,000	±6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	±7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	±8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	±9	900	-	-	-	-	0.1	±10	K	±1.0	F	SL
GOLD	-	0.1	±5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-	-	±20	500	-	-	-	-	-	-	-	-	-	-
* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%														

\* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%

## NOTES

- JAN: JOINT ARMY-NAVY
- RMA: RADIO MANUFACTURERS ASSOCIATION
- THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
- THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
- CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
- BUTTON CAPACITORS ARE GENERALLY 300 VDCW
- READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
- CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
- THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:  
CP MICA BUTTON: CC CERAMIC; CM MICA MOULDED; CN PAPER MOULDED

TM CC

Figure 99. Capacitor color and letter codes.



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